# Money Supply-Inflation Relationship in Postcommunist Russia

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## Abstract

Numerous empirical studies have been devoted to analyses of diverse inflation processes and have demonstrated consistent patterns for money price relationships for various market economies. While these propositions may be valid for market economies, they do not seem to be holding for the majority of transition economies. Except for Russia and Poland, no systematic pattern for the money price relationship was detected in transition economies in the first half of the 1990s, thus undermining the conventional monetarist view at least in the transitional context. If indeed this were the case, it would imply among other things, that traditional tools used for stabilization and control of inflation in advanced market economies may not be appropriate for transition economies.

The main objective of this dissertation is to scrutinize critically and rigorously inflation process in post-communist Russia, and the strength, dynamics, and causality of the relationship between inflation and various monetary aggregates. In particular, we test, whether lagged inflation has been an important determinant of contemporaneous rise in prices in this transition economy. In addition, we test whether there is a significant relationship between inflation and various monetary aggregates, and whether the lower inflationary environment that emerged in Russia in 1994, and especially in 1995, has caused the transmission of monetary impulses to future inflation to become both, slower and weaker. Furthermore, in a twofold aim, we shed some additional light on the issue of the choice of lag selection criteria in causality testing on one hand, and the issue of suitability of monetary aggregates for influencing and controlling inflation via policy instrument, in transition economies like the Russian Federation, on the other. Moreover, since each segment of our analysis contributes to the evaluation of the suitability of stabilization attempts in Russia, the role of international financial institution under whose influence stabilization was conducted, is inevitably brought under the spotlights. In this context, the dual role of the International Monetary Fund (IMF), of being the main coordinator of the Western assistance to Russia on one hand, and the main guide to Russian economic policy on the other, merits a special attention. Finally, suggestion for further research and conclusion from the analysis are outlined. The most important findings contained in this summary are delineated bellow.

Our analyses of macroeconomic instability in Postcommunist Russia emphasises the necessity of coordination of fiscal and monetary policies. Although Russia may not be an

economy with a fiscal dominant regime, the study demonstrates that continuing problems with balancing of government budget have led to eventual monetisation of the deficit. The analyses presented in the dissertation reiterate the notion that monetisation of the deficit, rather than the deficit themselves has been affecting the price level in Postcommunist Russia.

In contrast to earlier claims, this study produces ample evidence that lagged inflation has been an important determinant of contemporaneous rise in prices in Postcommunist Russia. Using very simple autoregressive models, economic agents were able to make consistent, unbiased, and efficient one-month ahead forecasts of inflation. Although not rational in the strong form of efficiency, inflationary expectations together with a prevailing inflationary inertia ought to have been taken into consideration in stabilisation efforts. The preference for the orthodox money-based stabilisation programs indicates that this was not the case in this transition economy prior to July 1995.

The analysis presented in this dissertation illustrates that the influence of changes in broad money growth on future inflation is considerably weaker and more protracted as the new economic environment in Russia has become more stable. Our evidence suggests that, the systematic pattern for money price relationship is fading in the new environment. Also, the average speed of transmission from changes in the growth of ruble broad money to inflation has shifted from just over three months in the first two and a half years of transition to just short of five months thereafter. In addition, the models of inflation presented in the dissertation give a reasonably good short hand description of the fundamental inflation process in Russia.

The results presented in this chapter also unequivocally point out that the choice of a lag length in distribute lag models can be critical for the outcome of causality testing. Among variety of ad hoc and statistical criteria for the optimum lag length selection, the Akaike's *FPE* criterion is found to outperform all others. Leaning on these results, the study found the existence of the feedback or bilateral causality between inflation and broad money in Postcommunist Russia. The findings question the wisdom of choosing money-based stabilization as the optimal policy advice for this transition economy.

Finally, this chapter argues that the IMF financial and good technical assistance to Russia in the 1990s has been less than generous. Not only the size of the assistance might have not been adequate but also the timing and actual disbursements of these funds were in sharp discord with pledges. More importantly, the IMF made a number of serious policy mistakes in both design and the implementation of the reforms, which significantly contributed to a delay in stabilisation of the economy and were thus costly in terms of the loss of welfare to the society. However, the IMF, as a main guide and a coordinator of the Western assistance to Russia, has done just enough to spoon-fed Russia to the point of no return to planned economy and autarky.

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**To Ivan and Luka**

## Introduction

This thesis investigates the relationship between money supply and inflation in the Russian Federation during transition period. Various aspects of the strength, dynamics, and causality of this relationship are brought together in the dissertation as well as other issues related to the stabilisation of inflation in this transition economy. Although there are number of theoretical issues dealt with, the thesis is dominated by the empirical testing. Each of these empirical tests is subjected to a rigorous diagnostic analysis. By the same token, each empirical testing and diagnostic analyses are preceded with a presentation of an appropriate methodology and an overview of the literature. This is particularly relevant for chapters two, tree, and four.

The scope of the study is limited to the case of Russia with occasional comparison with other European transition economies. The dissertation focuses generally on the stabilisation efforts in this transition economy until August 1998 and is set out in the following manner:

**Chapter One** analysis the roots of persistent inflation in Postcommunist Russia from both, monetary and fiscal perspectives. The chapter demonstrates that continuing problems with balancing of government budget have led to eventual monetisation of the deficit. Both, the theoretical framework presented in the chapter and the simple empirical analyses, demonstrate the necessity for fiscal correction. Thus, there may indeed not be a simple monetary cure for inflation. It follows that in order for stabilisation program to succeed, fiscal and monetary policy ought to be interrelated and coordinated.

**Chapter Two** analyses formation and rationality of inflationary expectations in Postcommunist Russia, a transition economy where various stabilization policies have initially ignored inflation persistence. In the absence of a sample survey of inflationary expectation and appropriate long run series of financial market indicators, the choice of model building technique is restricted to one that relies on the inflation history. A review of the literature on the topic of inflation expectations and rationality is followed by the data and methodology analysis, as well as the criteria for model selection. Empirical findings of the two competing models are presented and both models are rigorously scrutinised for their forecast abilities and rationality of expectations. The chapter clearly demonstrates that lagged inflation in Russian economy was a very important determinant of the contemporaneous rate of inflation and this ought to have been considered in designs of various stabilisation policies in the first half of the 1990s.

**Chapter Three** analysis the strength and dynamics of the relationship between inflation and various monetary aggregates in Postcommunist Russia. The chapter begins with the outline of the previous literature on the topic and the Russian monetary policy for the given period. Subsequently, the data and methodology, as well as the criteria for model selection, are delineated. This is followed by the empirical investigation of the significance of the relationship between money and inflation. Furthermore, we question whether the lower inflationary environment that emerged in Russia in 1994, and especially in 1995, has caused the transmission of monetary impulses to future inflation to become both, slower and weaker. To that end, we split the sample into two periods and conduct a number of empirical and diagnostic tests. The chapter concludes with the finding that broad money growth appears to have the strongest correspondence to contemporary inflation in post-communist Russia. However, this relationship proved to be unstable, and sensitive to changes taking place in the new economic and institutional environment. Furthermore, the average speed of transmission from changes in the growth of ruble broad money to inflation has increased.

**Chapter Four** builds upon analysis presented in Chapter Three and in a twofold objective it aims to shed some additional light on the issue of the choice of lag selection criteria in causality testing on one hand, and the issue of suitability of monetary aggregates for influencing and controlling inflation via policy instrument, in transition economies like the Russian Federation, on the other. The results presented in this chapter unequivocally point out that the choice of a lag length in distribute lag models can be critical for the outcome of causality testing. Among variety of ad hoc and statistical criteria for the optimum lag length selection, the Akaike's *FPE* criterion is found to outperform all others. Leaning on these results, the study found the existence of the feedback or bilateral causality between inflation and broad money in Postcommunist Russia. The findings question the wisdom of choosing money-based stabilization as the optimal policy advice for this transition economy.

**Chapter Five** examines the role of international financial institutions, particularly that of International Monetary Fund (IMF), in Russia's stabilisation efforts. It is argued, that the IMF's financial and good technical assistance to Russia in the 1990s has been less than generous. As a represent of the West, the IMF has consistently underestimated the size of the assistance needed for the successful stabilisation in Russia. In addition, the analysis demonstrates that on account of conditionality, the IMF disbursed by a long way fewer resources than pledges, not to mention lack of desire for debt forgiveness. Furthermore, it is noted that all of the Russian stabilisation programmes had an IMF approval and all of them failed. Moreover, the study scrutinizes the IMF's specific policies implemented in Russia. It concludes that the IMF has arguably made a significant number of specific policy mistakes that have inevitably aggravated long suffering Russian economy exacerbated by the pains of transition. Admittedly, transition process was a unique process and errors were inevitable. Nevertheless, given the reputation and enviable resources of the IMF, one cannot help thinking that they could have done much better and that at least part of the Russian socio-economic pains during transition were not inevitable.

# CHAPTER 1

# Emergence of Open Inflation and Stabilisation Efforts in Postcommunist Russia

## 1.1 Introduction

The beginning of the last decade of $20^{th}$ century signified the ultimate realisation that the task of mending the system of central planning was even beyond the resourceful and mighty Soviet Union. Substantial overhauls in 1957, 1965, and 1975 as well as piecemeal reforms attempted between 1985 and 1989 failed to adequately address the chronic inefficiencies of the system. In the environment of rapid deterioration of the economy accelerated by the dissolution of the Soviet Union and the breakdown of overall authority, the newly installed Russian government embarked on the path of radical economic reforms at the end of 1991. Subsequently, Russian greatest leap into market reforms in the eventful $20^{th}$ century was launched on 2 January 1992. The cornerstones of this endeavour resembled the Polish reforms[1] launched two years earlier and included a general decontrol of prices and trade, subsequent stabilisation of the domestic currency and privatisation.[2]

Perhaps the least successful part of the Russian reformers endeavour was the failure to regain macroeconomic stability of the economy. High and volatile rate of inflation characterised Russian economy throughout nineties. Rise in prices is most often analysed in the framework of the classical Quantity Equation. However, in the theoretical analysis of determinants of inflation, an appealing new strand of research that emphasise the role of fiscal policy has emerged. Advocates of this strand of research (Cochrane, 1998; Canzoneri *et al.*, 1998; Sims, 1994; and Woodford, 1994) hold view that there can be two regimes for price determination; the so called 'monetary dominant regime' and the 'fiscal policy regime'. In the former the price level is determined by the Quantity Equation. Thus, in this regime monetary policy de facto determines the price level while fiscal policy is said to 'remain reactive' (Komulainen and Pirtila, 2000). In the latter regime, the price level is

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[1] For differences between these two programs see Dabrowski (1997) and Hanson (1999), among others.

[2] To be precise, the government did not produce an overall plan, or even consistent program but rather a policy package that relayed on the decrees, laws and mini programs.

determined by the government intertemporal budget constraint. In other words, if the sequence of future surpluses falls short of financing the debt, the price level must adjust upwards, thus reducing the real value of the government debt. Hence, in this regime fiscal policy determines the price level and monetary policy 'remains reactive'. That is to say, in response to changes in the price level money supply adjusts to bring the money demand equation in balance.

The purpose of this chapter is to describe the emergence of inflation in postcommunist Russia from the viewpoint of both monetary and fiscal dominant regimes as well as their interaction. The chapter stops short of empirical determination of dominant regime mainly for two reasons. The first is to be found in unavailability of reliable data for the budget deficit, which would be likely to produce unreliable results given short time series. The second reason is that the empirical findings (Komulainen and Pirtila, 2000), for postcommunist Russian economy have already rejected the notion of fiscal dominance as an explanation of inflation. This is not to say that fiscal deficit does not matter for inflation. On the contrary, as the literature on traditional macroeconomic would suggest, and indeed as Komulainen and Pirtila, (2000) found, inflationary method of financing the deficit rather than the deficit *per se* affects the price level.

The next section (1.2) of this chapter discusses monetary roots of inflation in postcommunist Russia following liberalisation of prices. Section 1.3 briefly describes the new fiscal theory of price level, gives an overview of the literature and application of the theory on postcommunist Russia. Section 1.4 describes a theoretical framework for analyses of interaction between monetary and fiscal policies. Section 1.5 is devoted to analyses of Russian fiscal stance during transition and its repercussions on monetary policy in this period. Section 1.6 concludes with a summary of the analyses.

## 1.2 Monetary Roots of Inflation in Postcommunist Russia

### 1.2.1. Price Liberalisation and Emergence of Open Inflation in Postcommunist Russia

As mentioned above, Russian greatest leap into market reforms in the eventful 20$^{th}$ century was launched on 2 January 1992 by liberalisation of prices. Although very tardy, the initial domestic and external liberalisation efforts were just about sufficient to eventually succeed. However, these efforts were considerably more timid than was optimal with serious economic, intellectual, social, and political consequences (Åslund, 1995). One of most serious consequences of tardy and insufficient liberalisation was sustained high inflation. Although views about causes of inflation may be diverse, a rare consensus prevails among economists about detrimental effects of inflation on domestic economy.[3] High inflation, in transition economies, distorts relative prices, discourages investment, inhibits growth (Fisher *et al.*, 1996), generates uncertainty about key prices, encourages unproductive activities aimed only at hedging against inflation, contributes to a general climate of uncertainty and lack of trust in government policies, and hurt the most deprived group of society (Hernández de Catá, 1995). The failure of successful Russian governments to tame inflation has been the focal points of the academic literature on systemic transformation.[4] Hence, since the analysis of macroeconomic stabilisation is crucial to an understanding of the Russian economic transition we follow the suit of its critical assessment.

The announcement of sweeping liberalisation of previously controlled prices on 2nd January 1992 is often regarded as the beginning of the shock therapy in Russia. The chief motivation for the liberalisation of prices was to eliminate an excess demand in economy. In other words, the purpose of the elimination of a sizable monetary overhang or forced saving was to cut back the excessive demand for the artificially low priced goods and consequent queues. Although the sizable monetary overhang prevailed in the Soviet economy since its own version of a currency reform introduced in 1961, the phenomenon became particularly acute in 1991. In the latter year monetary authorities succeeding in creating as much as 137.5 billion rubles, which exceeded an accumulated total of 133.8 rubles printed between 1961 and 1990 (Ekonomika i Zhizn, 1992). The second purpose of the liberalisation of prices was to alter the pattern of production to suit consumer preferences rather than relying on 'state orders'. As it turned out, about 80 percent of producer prices and about 90 percent of consumer prices were free in value terms, at 1991 relative prices (Åslund, 1995). However, in contrast to government declarations, price controls remained on food and energy, which resulted in huge subsidies to these sectors contributing to a large extent to the continuing budget deficit.

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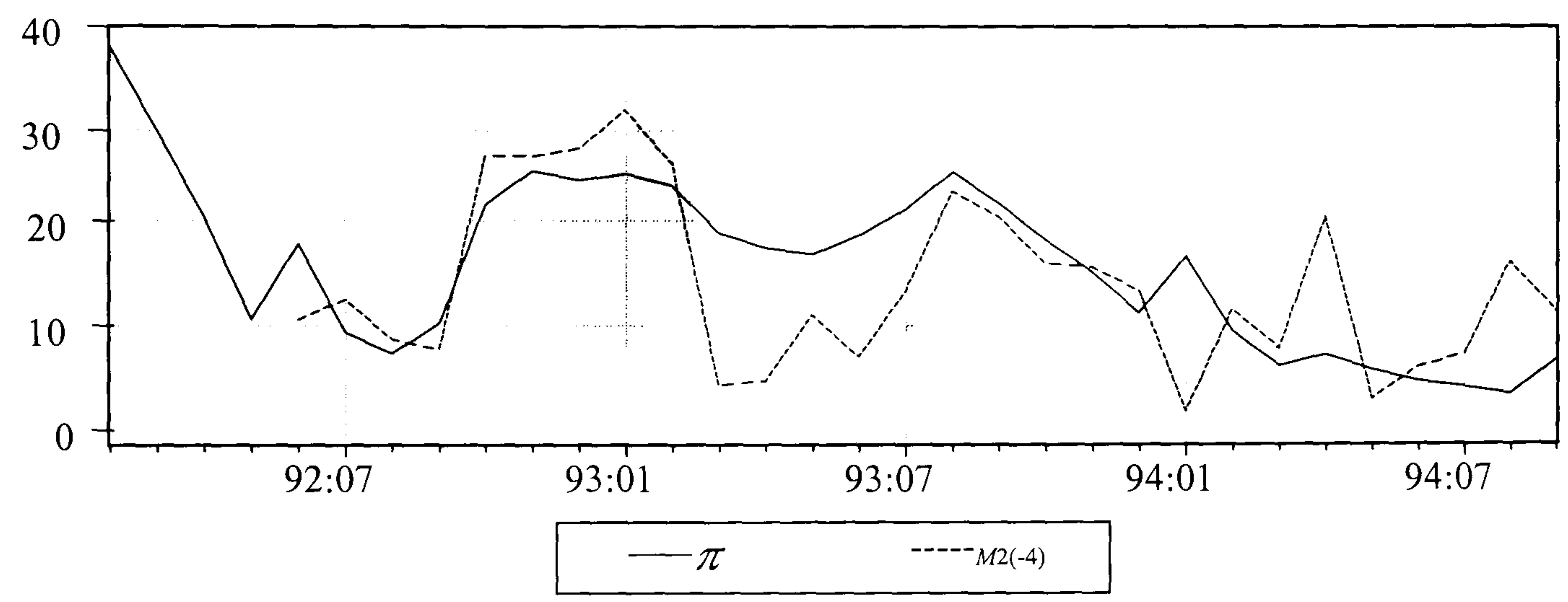
[3] See Dornnbusch *at al.* (1990); Fisher (1993); Burdekin *at al.* (1995); Heyman and Leijonhufvud (1995) among others.

[4] See Åslund 1995 for references.

Contrary to the forecast of various institutions including Russian Government and the International Monetary Fund (IMF) prices in Russia jumped in January 1992 as much as 245 percent.[5] The failure of these institution to envisage the size in the price jump upon liberalisation should be sought in the inappropriate use of sophisticated models of the demand for financial assets and reliance on the velocity of saving deposits rather than the velocity on cash, because the former proved to be much more variable than the latter (Gros and Steinherr, 1995). In any case, the elimination of monetary overhang should not constitute inflation *per se* since inflation is by definition continuous increase in the price level. Thus, one-of jump in prices should not amount to inflation in this case. As it happened, prices in Russia attained double digits in every month of 1992 and 1993, except August of 1992 (Nikolić, 2001).

Figure 1.1 Lagged Money Growth (*M2*) and Inflation ($\pi$) in Russia: 1992:02 - 94:09




Source: Nikolić 2000a

There is a considerable body of evidence that support widely accepted notion that the rise in prices in postcommunist Russia, in a few years immediately after liberalization, is a consequence of the rise in money supply.[6] More precisely, Fig. 1.1 indicates that the inflation rate ($\pi$), in the given period, appears to follow variations in the growth of ruble broad money supply (*M2*) four months earlier. Similarly, Nikolić (2000a) showed that the growth of *M2* in the given period is a reasonably good proxy for the rise in prices (Table

[5] See Nikolić, 2002.
[6] See Nikolić, 2000a for references.

1.1 and Fig. 1.2). Thus inflation in Russia appears to be a monetary phenomenon in the early years of transition.[7]

Table 1.1 OLS Estimates of the Distributed Lag Model (DLM) of Inflation for Russia: 1992:02-94:09

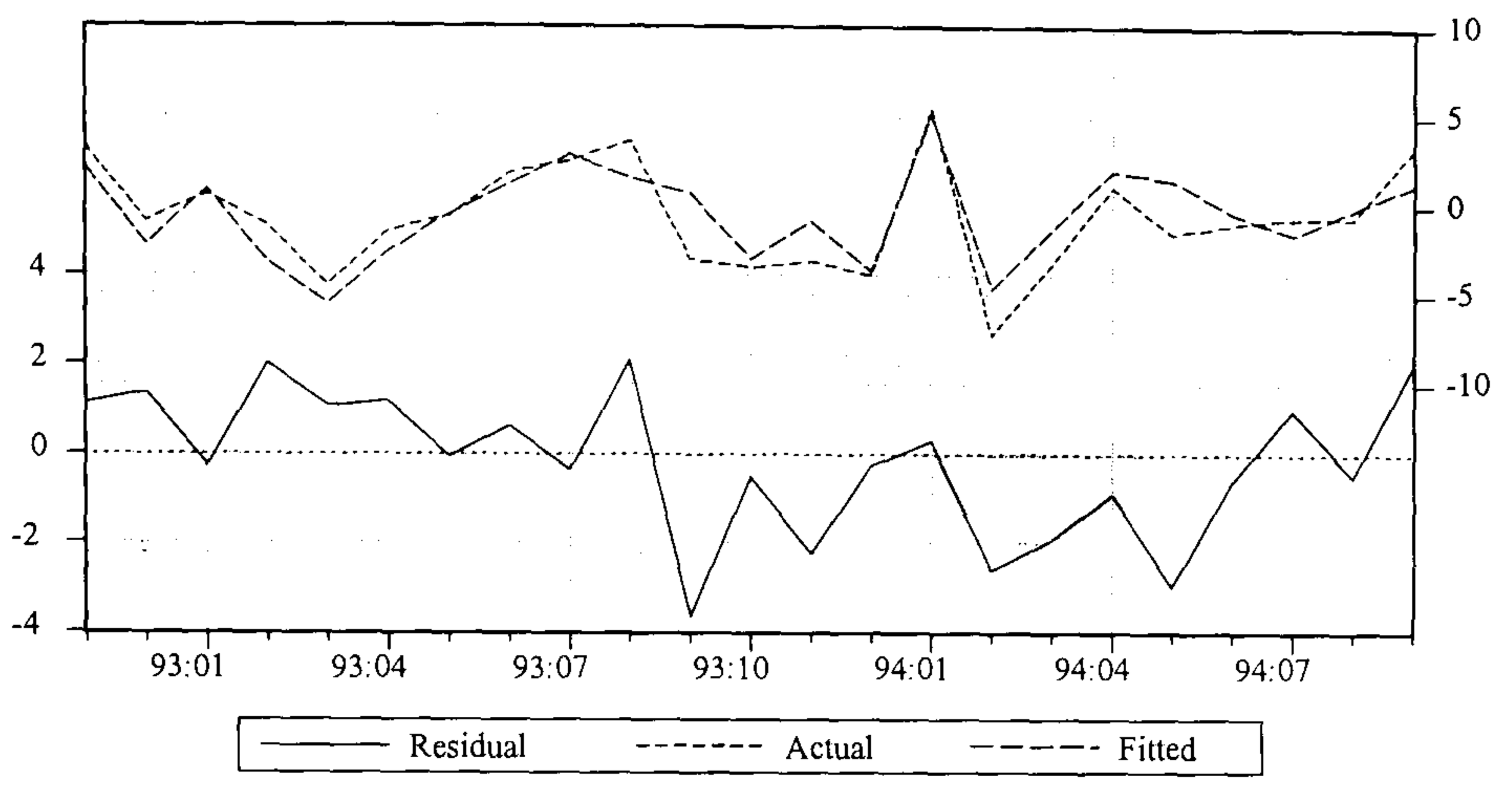
| Variable | Coefficient | Std. Error | $t$-Statistic | Prob. |
|---|---|---|---|---|
| $\Delta M2$ | 0.025028 | 0.099480 | 0.251587 | 0.8056 |
| $\Delta M2_{(-1)}$ | 0.328145 | 0.094653 | 3.466824 | 0.0047 |
| $\Delta M2_{(-2)}$ | 0.180520 | 0.117613 | 1.534870 | 0.1508 |
| $\Delta M2_{(-3)}$ | 0.212921 | 0.117796 | 1.807534 | 0.0958 |
| $\Delta M2_{(-4)}$ | 0.257276 | 0.084087 | 3.059635 | 0.0099 |
| $\Delta M2_{(-5)}$ | 0.211170 | 0.100409 | 2.103103 | 0.0572 |
| $\Delta M2_{(-6)}$ | 0.250186 | 0.090307 | 2.770400 | 0.0169 |
| $\Delta M2_{(-7)}$ | 0.038532 | 0.083230 | 0.462960 | 0.6517 |
| $\Delta M2_{(-8)}$ | -0.018118 | 0.081146 | -0.223274 | 0.8271 |
| $D_1$ | 3.668939 | 2.114631 | 1.735026 | 0.1083 |
| $D_6$ | -0.651321 | 1.919754 | -0.339273 | 0.7403 |
| $R^2$ | 0.706866 | Mean dependent var. | | -0.650348 |
| Adjusted $R^2$ | 0.462587 | S.D. dependent var. | | 3.029836 |
| S.E. of regression | 2.221126 | Akaike info. criterion | | 4.739840 |
| Sum squared resid. | 59.20080 | Schwarz criterion | | 5.282902 |
| Log likelihood | -43.50815 | $F$-statistic | | 2.893686 |
| Durbin-Watson stat. | 1.666928 | Prob.($F$-statistic) | | 0.042489 |

Source: Nikolić, 2000a.

*Note*: $D_1$ and $D_6$ are seasonal dummies, denoting seasonal variations in January and Jun, respectively.

[7] For the detailed analysis see Nikolić, 2000a.

Figure 1.2 Fit of the DLM of Inflation for Russia: 1992:02-94:09




Source: Nikolić, 2000a.

If inflation is indeed a consequence of the growth of money supply, the obvious question one can pose is what are the driving forces of this monetary growth? The answer to this question is best sought in the analysis of the balance sheet of the Central Bank of Russia (CBR). The accounting identities of the CBR imply that i.) an increase in net domestic assets ($\Delta NDA$) and net international reserves ($\Delta NIR$) are fundamental determinants of base money growth ($\Delta MB$); ii.) base money growth, often referred as high powered money, is the fundamental determinant of broad money growth ($\Delta M2$), which in turn is a fundamental determinant of inflation ($\pi$), as stated above and elaborated in the next chapter. The CBR activities thus drive inflation. However, there are intricate factors in these processes.

The first complication is related to a change of monetary base. Namely, an increase in net international reserves and domestic credits does not necessarily imply one for one increase in monetary base. The difference is a non-credit component of net domestic assets, other items net ($OIN$). Other items net include all other unclassified assets of the CBR and the net worth of the CBR. More specifically,

$$\Delta MB = \Delta NIR + \Delta NDA \tag{1.1}$$

$$\Delta NDA = \Delta NCD + \Delta OIN \tag{1.2}$$

$$\Delta NCD = \Delta NCG + \Delta NCB + \Delta NFSR = \Delta MB - \Delta NIR - \Delta OIN \tag{1.3}$$

where $\Delta NCG$, $\Delta NCB$, $\Delta NFSR$ stand for the variations in the CBR net credits to central government, commercial banks, and former Soviet republics, respectively.

The second complication arises in the relationship between base money and broad money. The relation between these two monetary aggregates depends on the currency in circulation ($C$), deposits ($D$), and commercial banks' reserves ($R$).[8] If the ratio of broad money to base money, referred to as the 'money multiplier', changes, base money growth and broad money growth will diverge. Typically, in periods of loose monetary policy, the money multiplier falls and vice versa. Fig. 1.3 demonstrates that, after initial volatility at the beginning of 1992, money multiplier began falling dramatically in the autumn of 1992 and was in a free fall until autumn of 1993. Needless to say this coincided with a period of a rapid credit expansion of the CBR. Additional reasons for the changes in money multiplier during the first years of transition lay in the changes in interest rates, reserve requirement and particularly in fluctuations of the sizable excess reserves of commercial banks', which itself signify, at least in part, inefficiency of the payment system in Russia.[9] Following period of relative stability, the money multiplier began to rise at the end of 1994 and continued its upward trend in the rest of the period under consideration. Conversely, this coincides with a period of relatively tight monetary policy and price stability as well as increased efficiency of the payment system.

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[8] More formally, money multiplier could be defined as follows:

$$\frac{M2}{MB} = \frac{C+D}{C+R} = \frac{\frac{C}{D}+1}{\frac{C}{D}+\frac{R}{D}}$$

where $C$ stands for currency in circulation, $D$ for deposits, and $R$ for commercial bank's reserves.

[9] For details see Granville, 1995.

Figure 1.3 Money Multiplier in Postcommunist Russia: 1992:02-94:09

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Source: RET, 1993-1999.

### 1.2.2 CBR Credits

Whatever the complications related to changes of money base, money multiplier, and relationship between broad money and inflation, might be, it is clear that various credits issued by the CBR were main cause of the growth of money supply.

Table 1.2 CBR Quarterly Flows of Credits (% of GDP): 1992:01-95:06

| Period | Commercial Banks | CIS States | Govern. (Min. Fin.) | Other[a] | **Total** | GDP[b] |
|---|---|---|---|---|---|---|
| q1-92[c] | 8.3 | 3.1 | 0.0 | 0.8 | 12.2 | 1832 |
| q2-92 | 10.2 | 10.3 | 12.7 | 0.5 | 33.7 | 2703 |
| q3-92 | 14.1 | 16.7 | 15.0 | 0.3 | 46.0 | 5042 |
| q4-92 | 18.5 | 4.6 | 15.7 | -1.6 | 37.2 | 8486 |
| **1992** | **15.0** | **8.7** | **13.5** | **-0.5** | **36.6** | **18063** |
| q1-93 | 7.9 | 6.1 | 9.3 | 4.3 | 27.5 | 13200 |
| q2-93 | 6.9 | 4.2 | 6.7 | -1.0 | 16.7 | 22000 |
| q3-93 | 5.4 | 1.7 | 5.6 | -0.4 | 12.3 | 48500 |
| q4-93 | 0.9 | 0.0 | 5.3 | 0.5 | 6.8 | 78000 |
| **1993** | **3.6** | **1.6** | **8.7** | **0.7** | **14.6** | **161700** |
| q1-94 | 2.0 | 0.1 | 6.7 | 1.4 | 10.1 | 85700 |
| q2-94 | 2.2 | 0.3 | 10.9 | -1.0 | 12.4 | 116800 |
| q3-94 | 1.7 | -2.5 | 9.0 | 2.8 | 11.1 | 183500 |
| q4-94 | 1.6 | 0.0 | 5.5 | -1.9 | 5.3 | 244000 |
| **1994** | **1.8** | **-0.7** | **7.7** | **0.1** | **8.9** | **630000** |
| q1-95 | 2.0 | 0.0 | 1.4 | 0.0 | 3.3 | 252000 |
| q2-95 | -0.6 | 0.0 | -0.1 | -0.1 | -7.0 | 354000 |

Source: Russian Economic Trends (RET), 1995; Granville (1995), and author's calculations.

*Note*: [a] CBR credits to Enterprises, to other (non-federal) forms of government and to extra-budgetary funds.

[b] Since the RET (1993-99) does not provide GDP monthly series for 1992 and 1993 these are taken from Granville (1995).

[c] An average monthly increase in flow of credits relative to December 1991 for the first quarter.

### 1.2.3 Net Credit to the Government

The first type of credit, net credit to the government ($\Delta NCG$), was used for the monetary financing of the budget deficit. In essence, there are three ways to finance the budget deficit: money creation, internal debt or bonds and external debt. The infancy of the domestic financial market and low credibility in the rouble denied an opportunity to the Russian government to finance its deficit by bond creation in the early stages of reforms. Similarly, lack of the disbursements of the pledged international assistance in the early years of reforms left the government with the only option: financing its deficit by money creation in this period.[10] Table 1.3 demonstrates the size of the budget deficit in the period between 1992 and 1998.

Table 1.3 General Balance of the Russian Government: 1992-98

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Source: European Bank for Restructuring and Development (EBRD), 2000.

The monetisation of the budget deficit was mainly achieved by variation of the monetary base. Financing government deficit in this way amounts to an implicit taxation. Two most common measures for the evaluation of the real value of the revenues that government can obtain by the money creation are seignorage (*SE*) and inflation tax (*IT*). Seignorage is usually defined as:[11]

$$SE = \Delta M/GDP \tag{1.4}$$

where *M* stands for an aggregate of money supply such as currency in circulation (*C*), base money (*MB*) or broad money (*M*2), and *GDP* stands for gross national product.

Conversely, inflation tax is a tax imposed on holders of monetary wealth and can be defined as follows:

$$IT = M\pi/GDP \tag{1.5}$$

$$IT = (C\pi + D(\pi - i))/GDP \tag{1.6}$$

[10] CBR credits to the government were prohibited in 1995 prior to an introduction of June stabilization program.

[11] This is a flow definition of seignorage that corresponds to the amount of goods and services the government can obtain by issuing additional money or forcing commercial banks to hold more reserves.

where $\pi$, $D$, and $i$ represent rate of inflation, ruble deposits and interest rate respectively.[12] Table 1.4 demonstrates that both seignorage and inflation tax amounted to a significant proportions of *GDP*, particularly in the first two years after liberalisation.

Table 1.4 Seignorage and Inflation Tax on Monetary Aggregates in Russia: 1992-98

| | $\pi$ | $\pi$ | *GDP* | *C* | *MB* | *M2* | *MB/GDP* | *SEC* | *SEMB* | *SEM2* | *ITMB* | *ITM2* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | end year | ann. av | R tril. | R bn | R bn | R bn | % | %GDP | %GDP | %GDP | %GDP | %GDP |
| 1991 | 161 | 97.2 | 1.4 | 191 | 182 | 958 | 13.00 | | | | | |
| 1992 | 2506.1 | 1526 | 19 | 1678 | 2235 | 6400 | 11.76 | 7.83 | 10.81 | 28.64 | 14.2 | 52.8 |
| 1993 | 840 | 875 | 171.5 | 13278 | 16691 | 32601 | 9.73 | 6.76 | 8.43 | 15.28 | 11.0 | 24.0 |
| 1994 | 204.4 | 311.4 | 610.7 | 35698 | 48000 | 97800 | 7.86 | 3.67 | 5.13 | 10.68 | 6.5 | 12.7 |
| 1995 | 128.6 | 197.7 | 1585 | 80800 | 103800 | 220800 | 6.55 | 2.85 | 3.52 | 7.76 | 3.6 | 7.5 |
| 1996 | 21.8 | 47.8 | 2200 | 103800 | 130900 | 288300 | 5.95 | 1.05 | 1.23 | 3.07 | 1.0 | 2.3 |
| 1997 | 10.9 | 14.7 | 2602 | 130400 | 164500 | 374100 | 6.32 | 1.02 | 1.29 | 3.30 | 0.6 | 1.3 |
| 1998 | 84.5 | 27.8 | 2685 | 187800 | 210400 | 448300 | 7.84 | 2.14 | 1.71 | 2.76 | 4.6 | 9.7 |

Source: EBRD (2000), RET (1993-99).

*Note*: $\pi$ = Inflation rate; *GDP* = Gross Domestic Product; C = Cash in Circulation, *MB* = Monetary Base, *M2* = Rouble Broad Money, SE = Seignorage, *IT* = Inflation Tax (Derived from the monthly figures of economic aggregates (RET, 1993-99) according to formula: $IT = ((M*\pi) / GDP) * 100$. Unlike in Layard and Richter, 1994, interest receipts from deposits are thus not accounted for.

The trouble with monetary financing from the government point of view is that, economic agents opt to hedge against tax on their monetary wealth. They do that mainly by converting rubles into foreign currency assets, the US dollar in particular. In doing so, the tax base (*MB*/*GDP*) as a proportion of *GDP*, in this case base money (*MB*), shrinks as demonstrated in Table 1.4.[13] Subsequently, if the government were to maintain a constant level of monetary financing of the budget deficit, inflation rate would need to accelerate. In other words if the tax base is shrinking the tax itself has to increase in order to maintain same level of monetary financing. An additional consequence of low monetisation is that it

[12] Providing inflation rate and real money balances remain constant (steady state), seignorage equals inflation tax.

[13] Share of base money in GDP in developing countries varies from country to country but averages about 15 percent.

makes the economy very sensitive to capital flows. An annual capital flight of several billions US dollars, which may be more than a third of the entire stock of ruble $M2$ valued in US dollars, could easily create serious macroeconomic problems and harm the entire financial system. Thus, the government has a stark choice; to find non-monetary way of financing budget deficit if deficit itself cannot be slashed, or to let inflation accelerate. From May 1993 the government started issuing various securities to help finance budget deficit. These securities covered 1.5, 10, and 40 percent of budget deficit in 1993, 1994, and 1995 respectively (Granville, 1995). In addition, external financing also contributed to deficit financing although this was considerably less than pledged (Nikolić, 2002). Eventually, in early 1995 the CBR was prohibited from financing budget deficit, which was essential for stabilisation of the economy, at least in the short to medium run.

### 1.2.4 Net Credit to Commercial Banks

Second type of CBR credits, net credit to commercial banks ($\Delta NCB$), in addition to being provided for liquidity through refinance rate, were also channelled to enterprises as a non-budgetary subsidy. These credits were allocated according to political bargaining rather than market consideration (Granville, 1995). In the dispute over jurisdiction of the CBR between the government and the Duma, the latter had the upper hand. The rationale for the Duma to increase the CBR issuance of credits to enterprises via commercial banks was to maintain the level of employment and help ailing industries and agriculture. These credits included military conversion subsidies and working capital credits (Granville, 1995). Clearly macroeconomic stabilisation was not high in order of preferences of the CBR in this period.

Table 1.2 demonstrates that CBR credit to commercial banks amounted to 15 and 3.6 percent of $GDP$ in 1992 and 1993 respectively. Most of these credits were designated to ailing enterprises and agriculture. Since these credits were issued via commercial banks, the responsibility for their repayment laid with the banks, at least theoretically. However, no action was taken at least until 1994 against a bank or a firm, which could not reimburse such a loan (Granville, 1995). Moreover, since real interest rates on these credits were negative, directed credit to enterprises amounted to the grants. When in November 1993 positive real interest rates were introduced, banks started to refuse to channel these credits.

Having being used as a conduit for directed credits to enterprises, commercial banks were slow to forward these funds to enterprises, building up massive excess reserves (RET, 1995). The excess reserves were about four times greater than required reserves in 1992 (Granville, 1995). Similarly the former were twice as much as the latter in 1993 (Granville, 1995). This is a puzzling phenomenon which probably could be partly explained by the inefficiency of the financial system, large credit risk, and an opportunity for the banks to delay channelling directed credit and buy foreign assets which would yield considerable gain in a short time span given environment of high inflation. It is however difficult to defend this bank strategy from the rational point of view, even though it is highly likely that the inflation tax imposed on these non-interest bearing funds was rolled to deposit holders in terms of smaller saving rates. On the other hand, the government gained extra revenue in terms of inflation tax on these funds.

### 1.2.5 Net Credit to Former Soviet Republics

Third kind of the CBR credit, net credit to former Soviet republics ($\Delta NFSR$), provided both cash and non-cash credits to 'near abroad' countries enabling those to continue trading with Russian enterprises. Cash credits given to former Soviet republics were intended to minimize dislocation of central planning's organic enterprise links between these states. That implies smaller trade shocks and lower fall in output. In addition to cash credits, many non-Russian enterprises were able to obtain unauthorized credits ('non-cash' rubles) from the Central Bank of Russia via national central banks. The dual money system, characterized on one hand, with unlimited supply of non-cash credits and a hard constraint on the delivery of cash on the other, was particularly costly to Russia in the first year of transition. Credits to other FSRs amounted in 1992 to at least 8.5 percent of Russian *GDP* if delivery of cash is excluded, and 11.6 percent otherwise, in terms of the CBR credits alone (Granville, 1997). Needless to say, such substantial increase in money supply inevitably fed into higher prices and much aggravated stabilization efforts. Although it has four distinct phases, the destabilizing effects of the Ruble zone prevailed until November of 1993. In July of 1993, the CBR suddenly withdrew pre-1993 ruble notes, which, together with the collapse of negotiations between Russia and Kazakhstan in November 1993, effectively sealed the fate of the old Ruble area.

### 1.3 The Fiscal Theory of Price Level and Its Application to Russia

In the classic macroeconomic literature prevails the view that inflation has monetary determinates such as money supply and exchange rate. In contrast, the crux of the new fiscal theory of price level (FTPL) lays in the notion that it may well be conceivable that the price level must adjust to equilibrate the real value of nominal government debt with present value of surpluses (Komulainen and Pirtila, 2000). However, the quantity theory and fiscal theory of price determination are not mutually exclusive but they are rather various strands of the same theory (Cochrane, 2000). In fact the origins of the new fiscal theory are obvious in the work of Sargent and Walace (1986) and their notion of interaction between monetary and fiscal policies. This theory is further developed and formalised recently by Woodroff (1994), Sims (1994), Burnside *et al.* (1998), and Canconeri *et al.* (1998).

Unsurprisingly the new theory has attracted considerable criticism. The critics charges that since the theory rules out possibility of government default the model leads to an over determination of the price level in the fiscal regime (Buiter, 1999). In addition, it is argued (Buiter, 2002), that the FTPL model is misspecified since it assumes that the government's intertemporal budget constraint needs to be satisfied only in equilibrium. Similarly, Cochrane (1998) argues, should the government violate the present value budget constraint the model could not be empirically tested since the prices would react and the off-equilibrium price sequence would remain hidden.

Despite strong criticism, the new fiscal theory has found application in transition economies since most of them have experienced persistent budget deficit and high inflation rates. Among theoretical papers it is worth mentioning the work of Begg and Wyplosz (1999) among others. The authors used the fiscal theory of price level to emphasise necessity of prudential stability in countries of Central and Eastern in their quest to join European Union. Similarly, Fakin and de Crombrugghe (1997) argue that after a dramatic shift away from subsidies in the early years of transition, the countries of Central Europe still show signs of an unsuccessful fiscal adjustment, insufficient deficit reduction, and loose expenditure policy.

Although fiscal issues have usually been overshadowed by monetary ones in transition economies the interest in fiscal policy has intensified in the wake of August 1998 Russian financial crises. Vast number of authors emphasise the importance of controlling fiscal deficit to achieve price stability (see Coricelli, Dabrowski and Urszula, 1998; Budina and van Wijnbergen, 1997; Barbone and Marchetti, 1995; Buiter, 1997; Dabrovski, 1999; Cottareli and Doyle, 1999; Fakin and de Crombrugghe, 1997, among others).

Having experienced consistently high level of inflation during transition, Russian fiscal policy has attracted considerable attention. Prior to August 1998 financial crises, perils of the unsustainable Russian budget deficit have been emphasized by Lopez-Claros and Alexashenko (1998), Sinel'nikov-Murilev and Trofimov (1998), and Cheasty and Davis (1996) among others. In the wake of August 1998, Russian fiscal performance attracted wider attention, as mentioned above. Although economist rarely achieve consensus, there was little doubt among researchers that the cause of financial meltdown in Russia in that year was to be sought in poor fiscal performance coupled with other internal and external factors (see Nikolić, 2000a; Kharas *et al.*, 2001; Desai, 2000; and Sutela, 2000, among others).

However, empirical findings for the premise that inflation in Russia is caused by the fiscal deficit are pretty thin. This conclusion is also confirmed in a recent study of the extent to which inflation has been affected by the fiscal deficits. Namely, using vector-autoregressive models (VAR) Komulainen and Pirtila (2000) have recently studied whether fiscal deficit causes inflation in Romania, Bulgaria and Russia. While the authors have found some evidence that the fiscal deficit has increased inflation in Bulgaria, they rejected the null hypothesis that fiscal deficit was significant determinant of inflation in both Romania and Russia. According to the authors, these findings did not support the presence of fiscal dominant regimes in these countries. In other words, Komulainen and Pirtila (2000) found the price level in Russia and Romania to be determined in the monetary dominant regimes by the quantity theory of money. This however, is not to say that fiscal policy does not matter. On the contrary, it does, as traditional macroeconomics would suggest. Komulainen and Pirtila (2000) findings simply underline the notion that the inflationary method of financing the deficit, rather than the deficit themselves, affect the price level.

## 1.4 Frameworks for Analysis of the Impact of Monetary and Fiscal Policies on Macroeconomic Stabilisation

Predictably, an expansionary monetary policy of the CBR was not a conductive environment for the overdue macroeconomic stabilisation. Unlike in other transition economies, several, mainly half-hearted stabilisation programs, implemented in Russia between 1991 and 1994, had a very little success. Similarly, mid 1995 stabilisation effort, after initial success, ended in the severe financial crises in August 1998. It has become conventional wisdom that these programs failed because they were not supported by structural and institutional reforms (Gavrilenkov and Kuboniwa, 1997). In the absence of the structural and institutional reforms most of the macroeconomic problems arose from the fiscal side. Subsequently, monetary policy was used as an adjustment tool. It follows that in order for stabilisation program to succeed, fiscal and monetary policy ought to be interrelated and coordinated. The interaction between fiscal and monetary policies can conveniently be analysed in the Sargent and Wallace (1976, 1986) framework.

### 1.4.1 Fiscal and Monetary Framework of Stabilisation

In the Sargent and Wallace (1976, 1986) framework interaction between policymakers (monetary and fiscal authority) and the public (private agents) is endogenised. On the one hand fiscal authority take decisions on public expenditure and tax rates, while monetary authority decide about composition of the government debt. They do so by maximising their objective function subject to the constraints imposed by the behaviour of the public. On the other hand, the public decides about consumption, investment, and employment and is assumed to pay the imposed taxes.

Rational Expectations Hypothesis (Muth, 1961) postulates that future rates of inflation are conditioned by agents' perceptions of long-term government monetary and fiscal policies. The agents are expected to change their 'strategy of rules' whenever there is a 'regime change' in government policies (Sargent and Wallace, 1976). Private agents limit government action and determine government budget constrain by choosing how much and what combination of elements of government debt to hold. Hence, monetary and fiscal policies must be coordinated because the government faces a budget constraint. It follows that there is no "purely monetary" cure for inflation.

The budget constraint thus becomes pivotal in the analysis of high inflation stabilisation in the Sargent and Wallace framework. Utilising this framework, Eq. (1.7) represents the government budget constraint given by Sargent and Wallace (1976, 1986):

$$G_t - T_t = (H_t - H_{t-1})/\pi_t + (B_t - B_{t-1}) - r_{t-1}B_{t-1} \tag{1.7}$$

where $G_t$ and $T_t$ represents real government expenditures at time $t$ and real taxes net of transfers (except for interest payments on the government debt) at time $t$; respectively; $H_t$ is a stock of base money at time $t$; $\pi_t$ is the price level at time $t$; $B_t$ is the real value of one-period government bond issued at $t$ and paid off at $(t+1)$; $r$ is the net real rate of interest.

Eq. (1.7) specifies that a real government primary or non-interest budget deficit ($D_t = G_t - T_t$) at time $t$, can be financed by a combination of an increase in monetary base and/or issuing to the public an interest bearing debt. Following Keynesian tradition, this framework assumes that the public is willing to hold interest-bearing government debt on the same terms applicable to private debt. The upper bound ($\bar{B}$) of public's willingness to accumulate real interest-bearing government debt ($B_t$) is assumed to be constraint by the total wealth in the country. In practice $\bar{B}$ is most often far lower than the total wealth.

Similarly, public willingness to accumulate the other government debt, the level of stock of base money, is determined by the version of Cagan (1956) function of demand for money (Eq. (1.8)). It describes the demand for the real base money as a decreasing function of the expected rate of inflation in the following manner:

$$\frac{H_t}{\pi_t} = \alpha_1 - \alpha_2 E_t\left[\frac{\pi_{t+1}}{\pi_t}\right] \qquad \alpha_1 > \alpha_2 \geq 0 \tag{1.8}$$

where $E_t[\cdot]$ is the value of $[\cdot]$ expected to prevail by the public as of time $t$. Eq. (1.8) depicts the demand for real base money as a decreasing function of the expected gross rate of inflation. Solving Eq. (1.8), $\pi_t$ can be expresses solely in terms of expected future values of $H_t$:

$$\pi_t = \frac{1}{\alpha_1} \sum_{j=0}^{\infty} \left( \frac{\alpha_2}{\alpha_1} \right)^j E_t H_{t+j} \qquad (1.9)$$

Eq. (1.9) describes the determination of price level at time $t$ by interaction of the public's preference for holding high powered money (parameters $\alpha_1$ and $\alpha_2$) with the expected path of high powered money now and into the indefinite future. It follows that the government deficit could influence the price level solely through the effects on the expected path of high powered money. As pointed out by Sargent (1993) this is a crux of monetarist supposition that inflation is always a monetary phenomenon.

However, the government deficit and path of high powered money do not need to be necessarily rigidly linked. The reason is that the government can cover its deficit by the interest bearing government debt, at least temporarily and to a point, as shown in Eq. (1.7). Hence, under the Sargent's (1993) system, made of Eqs. (1.7) and (1.9), the inflationary consequences of government deficits depend delicately on the government's strategy for servicing its debt.

There are evidently two clear-cut alternative debt-servicing strategies for the government as well as a combination of those. The two strategies are i) a strict Ricardin regime, and ii) Friedman (1949) rule. The former regime is not inflationary, at least initially, while the latter is. More precisely, in the strict Ricardian regime the government always finances its entire deficit or surplus by issuing or retiring interest-bearing government debt. Sargent (1993) shows that this kind of regime has no effect on the price path, as long as the deficit is of a temporary nature, since it is not permitted to have effects on the path of base money. In contrast, according to Fridman (1949) rule, deficits are always to be financed entirely by issuing additional base money. Subsequently, the time path of government deficits affects the time path of the price level via increase in money supply in a rigid and instant way, as shown in Eq. (1.7) (Sargent, 1993).

There are a number of combinations of above mentioned regimes which government can use. For example, Sargent (1993) cites Bryant and Wallace (1980), and Sargent and Wallace (1986), who have described the debt-servicing regimes that are intermediate between Ricardo's and Friedman's. In these regimes, issuing high powered money will affect the price path sooner or later. The time lag of the effects would depend on the parameters $\alpha_1$ and $\alpha_2$ in Eqs. (1.8) and (1.9) (Sargent, 1993).

The theme that monetary and fiscal policies are interrelated and must necessarily be coordinated is further extended by Sargent and Wallace (1993). Their extended analyses is centred on the premise that in the absence of fiscal authorities help, fighting current inflation with tight monetary policy must eventually lead to higher future inflation. In contrast, according to Sargent and Wallace (1993), fiscal correction is the necessary and sufficient condition for stabilisation.

The dimensions of the limits of the monetary policy are further illustrated by Sargent and Wallace's (1993) 'unpleasant monetarist arithmetic'. The authors argue that financing the debt by money and debt, shifting towards tight monetary policy, would lead to increase in the government debt in the future. The increase in the debt would be caused by the government interest burden increase. Given that there exists a limit on the public sector's willingness to absorb the debt, the government finds it difficult to sell its debt to the public except at falling prices, which in turn increases expenditures. In order to avoid insolvency the government resorts to inflationary money creation to finance its deficit. Thus, public perception of the government inability to meet the intertemporal budget constraint would cause an unexpected increase in inflation rate above the level initially expected by the agents. In other words, inflation will only occur if the present value of government's debt is not equal to the present value of all the government's surpluses expected in the future.

The only way to avoid inflation is to be offered by the fiscal authorities. Namely, the fiscal program must meet the intertemporal budget constraint to be accepted as credible evidence such that inflation will not be used to finance the budget. Should the long term government policies violate the budget constraint, the higher inflation rate would inevitably follow in the rational expectations model. In sum, the unpleasant arithmetic of Sargent and Wallace (1993) postulates that the central bank is prevented from successfully fighting inflation by itself if the fiscal authority persists in running a net-of- interest budget deficit.

### 1.4.2 Open Economy Framework

The analysis so far has concentrated on a closed economy. In an open economy framework, the government budget constraint (Eq. (1.7)) is also determined by the international economic transactions. These include financial and real resources transfers between trading nations. Thus, the government budget constraint for a small open economy becomes:

$$G_t - T_t = (H_t - H_{t-1})/\pi_t + (B_t - B_{t-1}) + r_{t-1}B_{t-1} + e_t(B^*_t - B^*_{t-1}) + r^*_{t-1}e_tB^*_{t-1} - e_t(R^*_t - R^*_{t-1}) \quad (1.10)$$

Rearranging Eq. (1.10) we obtain Eq. (1.11):

$$Dt + r_{t-1}B_{t-1} + r^*_{t-1}e_tB^*_{t-1} = \Delta H_t/\pi_t + \Delta B_t + e_t\Delta(B^*_t - R^*t) \quad (1.11)$$

where $Dt = G_t - T_t$ stands for the real government primary or non-interest budget deficit as described above; $e_t$ represents the real exchange rate at time $t$; $B^*_t$ represents foreign public debt at time $t$; $R^*_t$ represents foreign currency reserves at time $t$; and $r^*_t$ is an interest rate on foreign debt at time $t$. Hence, Eq. (1.11) states that the excess of real government spending, $G$ at time $t$, and domestic debt, $rB$, plus foreign debt service, $r^*B^*_t$, over real tax receipts, $T$, must be financed by one of the four sources: printing money, running down international currency (and/or gold) reserves, selling of public debt to the domestic sector or to the foreign sector. Running down international reserves, if those are sizable, can only provide temporary relief. The downside of this option is that depletion of reserves adversely affects the exchange rate. Similarly, borrowing either from domestic public or from abroad may induce domestic spending which in turn will likely affect the budget deficit.

## 1.5 Interaction of Fiscal and Monetary Policies in Russia During Transition

### 1.5.1 Budget Distortions in the Late Years of Communism in Russia

Budgetary problems and fiscal crises throughout Russian economic transformation have roots in the late years of communism. Failing system of central planning reflected a part of its inefficiency in the balance of state budget. Among important factors of mounting budget distortions at the end of 1980s were: i) fall in world prices of raw material ii) growing military expenditure caused by the arms race and the war in Afghanistan, iii) wrong economic policy decision in mid-1980s (e.g. attempt for new industrialisation, the anti-alcohol campaign sharply reduced budget revenues), and iv) series of large-scale disasters (Chernobyl, earth quake in Armenia). The deterioration of state finances, manifested through falling revenues and increased expenditures at the end of communist period is clearly shown in Table 1.5.

Table 1.5 Budget Balance in the USSR: 1985-1990



Source: Robinson, 2001.

### 1.5.2 Russia's Fiscal Performance During Transition

Russian reformers were aware of the problems with the budget deficit and envisaged to tackle it in the first stages of reforms. Even President Yeltsin was confident that deficit would be slashed and announced that the "budget deficit in 1992 should be almost non-existent or minimal" (Sovetskaya Rossiya, 1991).

In the event, the intentions of the reformers were too ambitious and fell far short of expectations. Table 1.3 demonstrates that budget deficit persisted to mar government efforts to stabilise economy throughout transition period. Main obstacles to the expenditure side of the state budget were the government inability to stop subsidy payments being made either by local authorities or by the CBR (Robinson, 2001). Conversely, tax collection has been one of the weakest elements of Russia's macroeconomic performance throughout transition period. Tax revenues have declined sharply during this period and according to official data, the actual tax revenues of Russia's enlarged budget (including the consolidated revenues of the federal and the regional budgets and those of the extrabudgetary funds) fell from over 44 percent of *GDP* in 1992 to less than 30 percent in 1996 (RET, 1997). The trend only slightly improved in 1997 as a result of one-off payment of tax arrears of several large enterprises, most notably Gasprom.

The key factors underlying the deteriorating revenue performance during transition period have been the following (RET, 1997):

1. decline in output and profits,
2. shrinking tax base due to the impact of tax exemptions, tax deferrals and other tax concessions,
3. statutory tax rates have been reduced under the profit tax and VAT reforms, so that excess wage tax was eliminated and the export tariffs phased out,
4. a deterioration in tax discipline; sharp increase in tax arrears[14], and tax evasion[15],
5. large share of tax revenues received in kind, which made fiscal policy less flexible.

Government fiscal position has been further undermined by an outdated and non-transparent tax code. More precisely, for almost a decade Russia had not had a comprehensive overhaul of its tax system. The old Law on the Principles of Tax System, introduced in 1991, was replaced by the new Tax Code, but only its first general part, and not before the beginning of 1999.

The insufficient budget revenues in 1992 and 1993 severely undermined the government stabilisation effort. More importantly for the reform process, a poor fiscal record of the government dealt a heavy blow to reformist parties in Parliamentary election in December 1993, and eventually forced their PM and finance minister out. According to Russian press, the shortfall in tax collection in 1993 was 30 percent (Rossiiskie vesti, 1994), while by the autumn 1994 it was as much as 50 percent (Segodnya, 1994). The dramatic decline in revenues in this period could not be offset sufficiently by slashing expenditures so that ballooning budget deficit exerted unbearable pressure on the exchange rate, which was slipping away from the CBR control. With reserves running low the CBR could not prevent Black Tuesday on October 11 when the ruble (R) to US dollar ($) exchange rate fell by 28%, jumping from R3,000 to almost R4,000 in one day (RET, 1994).

[14] In 1996, the stock of identifiable arrears to the consolidated budget were estimated at close to R 128 trillion or 5.7 percent of GDP, while arrears to the extrabudgetary funds were close to R 100 trillion or 4.3 percent of GDP (RET, 1997).

[15] The State Tax Service reported that at the beginning of 1997 about one-third of enterprises did not pay any taxes. In addition, only 16.6 per cent of enterprises were paying taxes that were due (RET, 1997).

The Black Tuesday of October 1994 brought home the depth of reform's failures in the area of budget financing in the previous three years as well as final realization that the days when the CBR could issue large credits without causing high inflation were over. As a consequence of this realisation, in the new stabilisation effort in 1995, the CBR was barred from financing budget deficit.

In the new policy environment the government tapped into a pool of domestic debt coupled with borrowing from abroad. The short-term treasury bills (GKO) and fixed coupon bonds (OFZ), although introduced in 1993, only took off in the aftermath of Black Tuesday as a result of the rise in the CBR discount rate. Subsequently, in 1996 the stock of GKOs and OFZs had pilled up to about 11 percent of *GDP* (RET, 1993-199) causing a major concern for the monetary authorities. Interest rate on these securities rose to over 100 percent in the same year and the state's domestic debt tripled (Izvestya, 1997). By the autumn of 1996, Russian commercial banks had no longer liquidity to finance the government debt market since the stock of GKOs and OFZs exceeded the total stock of ruble deposits in the banking system (EBRD, 1998). In order to ascertain control over the growing deficit and be able to finance it, the government had to find new pool of liquidity at the lower cost of borrowing. Given the lack of liquidity of the Russian banking sector, the only option for the government was to seek out external sources of deficit financing so as to roll over debt repayments into fresh bond issues and expand the debt market at a lower cost (Robinson, 2001). Subsequently the GKO market was open for foreigner in 1996. However, the demand for the GKOs peaked in 1997 when foreign investors acquired US$19.7 billion which was about 34 percent of entire stock of GKOs and OFZs (Robinson, 2001). Inevitably such high demand for these securities lowered interest rates on the government debt to less than 10 percent in the summer of 1997 (Robinson, 2001). Most of the foreign money invested in the government debt market in 1996 and 1997 was in short-term debt that matured in under a year. Maintaining investors' confidence was thus crucial for the roll over in new GKO issues of matured debt.

Investors observed the rise of accumulated deficits, which pushed up debt service costs for the future, and so increased the size of future deficits. As markets viewed the government's finances, and thus the exchange rate target, as unsustainable, this perception led to a higher currency risk premium, which resulted in upward pressure on interest rates

(Nikolić, 2000a).[16] The higher interest rates, in turn, led to an increase in the future debt service costs and so thus increased the future expected budget deficit. The spiral was further exacerbated by the adverse effects of a higher interest rate on growth, of dwindling foreign exchange reserves, and of the compounded perception of less than credible government policies, all of which eventually led the country into a variant of the debt-trap (Nikolić, 2000a).

The dire position of government finances and the economy as a whole was undermined further by the external and other internal factors (Nikolić, 2000a). The most important of the external factors, in the aftermath of the 1997 Asian crises, was the fall in confidence on the part of the international capital investors to invest in countries like Russia, which was, and still is, plagued by macroeconomic and structural weaknesses, particularly over-dependence on short term capital inflows (RET, 1998). The second adverse external factor was the fall of oil and other commodity prices. Among the domestic factors the most important were the excessively large budget deficit and the unsustainable build up of ruble-denominated debt. These adverse domestic factors originated from problems associated with poor tax collection mentioned above, non-productive government expenditures, a small and weak domestic capital market, a weak and inefficient banking system, poor corporate governance, and the continued accumulation of payment arrears (RET, 1998). The failure of the policymakers to address these issues in the relatively favourable investment climate of 1997 led Russia, in August 1998, into the worst financial crises of its transition period and contributed to the global financial turbulence. The ruble was effectively devalued and left floating while the government defaulted on its GKOs (Nikolić, 2000a).[17]

### 1.5.3 Empirical Indicators of the Government Non-Interest Budget Constraint in Postcommunist Russia

Using a simplified version of the Sargent and Wallace (1976, 1986) framework, we estimated the government budget constraint faced by the Russian government between

[16] The currency risk premium is defined as the difference between the interest rate for the same maturity instrument of ruble-denominated domestic debt, taking into account the depreciation expected under the current exchange rate policy, and dollar-denominated government debt.

[17] In 1998, the official exchange rate went from R5,96/$ to R20,65/$, a depreciation of 246 per cent. From August 1998 to end-March 1999, the ruble has depreciated 287 per cent, from R6,24/$ to R24,16/$ (RET, 1999).

1992 and 1998, albeit excluding the interest accrual on the government debts. More precisely, the Sargent and Wallace (1976, 1986) constraint described in Eq. (1.11), is simplified so not to include the interest accrual on the government domestic and foreign debts. The reason for this exclusion is that reliable data on the build up of interest on government debts were not available. Hence, after modification Eq. (1.11) takes the form expressed in Eq. (1.12):

$$Dt = \Delta H_t/\pi_t + \Delta B_t + e_t\Delta(B^*_t - R^*t) \tag{1.12}$$

Eq. (1.12) states that the real government deficit, $D$, at time $t$, must be financed by one of the four sources: printing money, $\Delta H_t$, running down international currency (and/or gold) reserves, $e_t\Delta(B^*_t - R^*t)$, selling of public debt to the domestic sector, $\Delta B_t$, or to the foreign sector, $\Delta B^*_t$.

Table 1.6 Simple Empirical Assessment of the Non-Interest Budget Constraint - Russia: 1992-98

| | *GDP* R bn. | $D_t$ R bn. | $D_t$ % *GDP* | $\Delta H_t$ R bn. | $\Delta B_t$ R bn. | $\Delta R_t$* \$ bn. | $\Delta B_t$* \$ bn. | $e_t$ R/\$ |
|---|---|---|---|---|---|---|---|---|
| 1991 | 1400 | | | | | 8.2 | | 0.1692 |
| 1992 | 19000 | 2057.08 | 10.83 | 2053 | | 0.744 | 10.60 | 0.4145 |
| 1993 | 171500 | 14699.73 | 8.57 | 14456 | 207.63 | 4.354 | 33.30 | 1.247 |
| 1994 | 610700 | 43882.8 | 7.19 | 31309 | 12532.37 | -1.869 | 9.80 | 3.55 |
| 1995 | 1585000 | 116721.9 | 7.36 | 55800 | 60975.70 | 10.386 | -1.20 | 4.64 |
| 1996 | 2200000 | 190534.5 | 8.66 | 27100 | 163393.10 | -2.841 | 4.60 | 5.57 |
| 1997 | 2602000 | 181362.2 | 6.97 | 33600 | 147767.20 | 1.936 | 1.10 | 5.974 |
| 1998 | 2685000 | 49406.32 | 1.84 | 45900 | 2176.51 | -5.305 | 57.60 | 21.14 |

Source: EBRD, 1999; RET, 1993-99; IMF, 1999; Nikolić, 2002, and author's calculations.

Table 1.6 demonstrates that the non-interest nominal budget deficit in Russia between 1992 and 1998 was very significant. In addition, Table 1.6 reveals that money supply was a principal tool for financing the deficit between 1992 and 1995. Although monetization of the deficit continued in the following years, the principal source of financing the deficit between 1996 and 1998 was from domestic borrowing. The domestic borrowing, in these three years, was about twice as much the increase in base money. In 1998 alone, even though the government could not borrow after the default in August of that year, the increase in the domestic borrowing for the whole year amounted to 14.4 percent of *GDP*, which was at similar level to an increase in the previous year. Thus, even from the limited evidence, presented in Table 1.6, it is clear that the government financing of its deficit had an unsustainable path. The international financial investors could clearly observe that the government finances are in disorder and that the government was poised to default on its obligations sooner or later.

## 1.6 Conclusion

Our analyses of macroeconomic instability in postcommunist Russia lays heavy emphasis on the necessity of coordination of fiscal and monetary policies. The formal analysis demonstrates that monetary authorities are prevented from successfully fighting inflation by itself if the fiscal authority persists in running a net-of-interest budget deficit. Needles to say, the problem of fighting inflation becomes far more confounded should monetary authority subordinate macroeconomic stability to other socio-economic aims.

Although Russia may not be an economy with a fiscal dominant regime, the study demonstrates that continuing problems with balancing of government budget have led to eventual monetisation of the deficit. In a few years after price liberalisation budget deficit was mainly financed by money creation. In the following years, domestic borrowing well surpassed the level of money creation, but eventually became unsustainable leading the economy into the financial crises of August 1998. Naturally, both periods were characterised by the lack of macroeconomic stability.

Both, the theoretical framework presented in the chapter and the simple empirical analyses, demonstrate the necessity for fiscal correction. In this framework fiscal correction is the necessary and sufficient condition for stabilisation. This is not to say that the Russian fiscal regime has dominated over monetary one. Rather, we want to reiterate the notion that monetisation of the deficit, rather than the deficit themselves has been affecting the price level in postcommunist Russia.

# CHAPTER 2

# Inflation Expectation in Postcommunist Russia

## 2.1. Introduction

The central role of inflation expectations has long been recognized in both macroeconomic theorizing and stabilization policy analysis. Wage bargaining, price setting, asset allocation and investment, all depend on inflationary expectation on one way or another. While inflation expectations received scrupulous attention in market economies over a long period of time, interest for the topic in the former socialist economies arose only with liberalization attempts at the beginning of transition. Given the lack of experience with open inflation on the part of economic agents in majority of transition economies, the literature on the formation of expectations in these economies is still rather scant. Hence, the objective of this chapter is to analyze formation and rationality of inflationary expectation in postcommunist Russia, a transition economy where various stabilization policies have initially ignored inflation persistence. In the absence of a sample survey of inflationary expectation and appropriate long run series of financial market indicators, the choice of model building technique is restricted to one that relies on the inflation history. The findings of this chapter sharply contrast the claims that lagged inflation has been relatively unimportant in explaining inflation in transition economies (Cottarelli *et al.*, 1998; Coorey *et al.*, 1998; and Cottarelli and Boyle, 1999).

The balance of this chapter is divided as follows. Section 2 gives a brief overview of the literature and the origins of open inflation and inflationary expectations in Russia. In section 3 the data and methodology, as well as the criteria for model selection, are delineated. The empirical results are reported and discussed in section 4, while section 5 gives an alternative model. Sections 6 and 7 are devoted to tests for forecasting abilities of the models and for rationality of expectations, respectively. Section 8 outlines some policy implication and suggestions for further research while section 9 concludes with the summary of the findings.

## 2.2 A Brief Overview of Inflation Expectations in Postcommunist Russia and the Literature

Early analysis of formation of expectations were characterized by emphasis on a weighted average of past changes (Fisher, 1930) and the role of exogenous psychological factors, i.e., 'animal spirit' (Keynes, 1933). In other words, expectations were assumed to be subject to a high degree of inertia but also to unexplained waves of optimism or pessimism. Following the Second Word War, expectations were modelled in some deterministic manner, mainly assuming that the expected value of a certain variable could be proxied by its observed values in a recent past (Cagan, 1956; Frenkel, 1973; Holden and Peel, 1977; among others). Alternative measures to the arbitrary modelling of price expectations could be based on financial market indicators or a survey-based data. While the former direct measurement of inflationary expectation uses some financial indicator such as forward interest rate for example (Mishkin, 1990; Svensson, 1993; Frankel and Lown, 1994; and Söderlind, 1995; among others), the latter uses some sample survey like Livingston Survey for the United States or the Gallup poll for the United Kingdom.[18] Limitations of these kinds of modelling gave impetus to development of the rational expectation hypothesis (REH) (Muth, 1961; and Sargent and Wallace, 1976, among others). Although REH can be applied to a wide range of economic variables, most of the theoretical and empirical work has focused on the formation of inflationary expectations.

The particular interest in the role of expectations in market economies arose with the disillusionment with the long run validity of the Philips curve, and stagflations of 1970s.[19] It was argued that, the coexistence of high and increasing unemployment with rapid and accelerating inflation contain an expectations hypothesis that prices rise because people expect them to rise (Carlson and Parkin, 1975). Since formation of these expectations is crucial for the genesis of inflation persistence (Ball, 1991), this topic has received a scrupulous attention in stabilization policies, particularly, but by no means exclusively, in inflation targeting regimes. Various types of models of expectations have been given, particularly for the United States. These models have been broadly classified as those falling under the adaptive expectations hypothesis (Fisher, 1930; Cagan, 1956;

[18] For description of the Livingston data see Turnovsky (1970), Carlson (1977), and Figlewski and Wachtel (1981) among others. For the Gallup Poll survey see seminal work of Carlson and Parkin (1975).

[19] For theoretical discussions see Friedman (1968), Phelps (1968), and Lucas and Rapping (1969), among others.

Frenkel, 1973; among others), hybrid models of expectations,[20] the REH (Muth, 1961; Poole, 1976; Shiller, 1978; Sargent and Wallace, 1976; among others), and direct measure of inflationary expectations in a form of a sample survey measure of inflation (Turnovsky, 1970; Carlson, 1977; Figlewski and Wachtel, 1981; Carlson and Parkin, 1975) or financial market indicators (Mishkin, 1990; Svensson, 1993; Söderlind, 1995). Researchers have paid the greatest attention to Livingston data published by Philadelphia *Enquirer*. Reportedly, the most striking feature of this series is its poor forecast ability (Wachtel, 1977). In particular, the actual inflation exceeds expectations in over 70 percent of the surveys over the period 1947-1973. In addition, the poor prediction of inflation, over the entire period, is demonstrated by the low $R^2$, which does not exceed 30%, and the large constant term of 2.05 per cent (Wachtel, 1977). As far as rationality of Livingston data is concerned, the findings of various researches are generally not in accord. While many researchers found these data consistent with rationality (Turnovsky, 1970; Mullineaux, 1978; Mullineaux, 1980, among others), others rejected the REH even in the weak form, except for the specific period 1957-1971 (Pesando, 1975; de Menil and Bhalla, 1975; Carlson, 1977, Holden and Peel, 1977; Figlewski and Wachtel, 1981, among others).[21]

In contrast to market economies, where formation of both, consumers' and producers' inflation expectations received scrupulous attention, the topic has received a scarce interest in transition economies. Although inflation expectations were not at the core of their analysis Hoggarth (1996); Allen *et al.* (1996); Korhonen and Pesonen (1998); and Nikolić (2000), all showed that one-month lagged inflation is among the most important determinants of the contemporaneous inflation in Russian economy. Quite the reverse findings, for all transition economies as a whole, could be found in Cottarelli *et al.* (1998), and Coorey *et al.* (1998). The feeble interest for the topic could perhaps be explained by the lack of experience with open inflation in majority of transition economies, lack of surveys data on expectations of inflation as well as non-availability of financial and the long run time series of inflation. In the absence of means of independently measuring expectations, we have to postulate a scheme for generating expectations in terms of observable variables.

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[20] Hybrid models of expectations can be further classified as the adaptive-regressive or habitat models (Modigliani and Sutch, 1966; Modigliani and Shiller, 1973; Frenkel, 1976; among others) and partially rational expectations models (Walters, 1971; Feige and Pearce, 1976; Brinner, 1977, Spitäller, 1978; among others)

[21] For a detailed review of the literature see Gramlich (1983) and Ball (1991) and the references therein.

However, prior to empirical analysis, a brief description of the history of open inflation in postcommunist Russia is in order.

In the presence of monetary overhang, Russian liberalization of prices of 2nd January 1992 was bound to cause an explosion in prices. Indeed, in the first month of liberalization, prices rose by about 245 percent (*Russian Economic Trends* (*RET*)), far in excess of International Monetary Fund (IMF) and the Russian government predictions. This mechanism of initial jump in prices could be conveniently analyzed with a help of the Quantity Equation. An often-used variant of the Quantity Equation is the income version given by Pigou (1927):

$$M V = P Y \tag{2.1}$$

where $M$ is defined as the total quantity of money in the economy, $V$ represents the income velocity of circulation defined as the average number of times a unit of currency turns over in the course of financing the year's final activity, $P$ is implicit price deflator and $Y$ is national income. If prices were fixed in time $t$ but liberalized in time $t$+1 the jump in prices should be equal to:

$$\frac{P_{t+1}}{P_t} = \frac{(M_{t+1}/M_t)(V_{t+1}/V_t)}{Y_{t+1}/Y_t} \tag{2.2}$$

Subsequent analysis of prices movements after price liberalization in the short run can safely ignore the changes in income and money supply. That is because there is no reason to expect that government will print money at the same time it undertakes price liberalization. By the same token, there is no a priori reason to expect that income would change dramatically because of liberalization either. After all, it would take time for these changes to materialize. Hence, for, say, the first month after liberalization, one can assume that $Y_t$+1/$Y_t$ and $M_t$+1/$M_t$ are both approximately close to one. It follows that the prediction of the jump in prices requires only prediction of an increase in velocity. It is in this area that serious miscalculations occurred. While the IMF and the Russian Prime Minister estimated the size of monetary overhang about 50 per cent (Gros and Steinherr, 1995) and price jump of 100 percent (Rossiiskaya Gazeta, 1992), respectively, the prices jumped as much as 245 percent in January 1992, as mentioned above. One of the probable causes of this miscalculation should be sought in the use of sophisticated models of the demand for financial assets that give quite good results over the long run in developed market economies (Gros and Steinherr, 1995). However, these models proved inadequate in Russia and other transition economies, were households had essentially only 3 assets: cash, saving deposits and foreign currencies. Another probable cause for the miscalculation of price jump was reliance on the velocity of saving deposits rather than the velocity on cash, because the former proved to be much more variable than the latter (Gros and Steinherr, 1995).

Since empirical work on the demand for money balances in transition economies was very limited and even non-existent for newly independent states, the behaviour of velocity in subsequent stabilization programs was seriously misjudged. Stabilization programs for Baltic States, Russia, and other countries of the former Soviet Union, envisaged that inflation would not respond immediately to monetary tightening. Therefore they projected a rise in velocity of broad money in the first quarter of the program, assuming that velocity would subsequently remain broadly stable or even decline. In the event, velocity continued to rise into subsequent quarters in almost all of the cases where stabilization was not successful.

Whatever the initial jump in prices may be and however calculated, price adjustment caused by the elimination of monetary overhang would not constituted inflation if prices did not continue to rise in the following months. It would merely result in the one-off change in the price level. This is because, by definition, inflation is a continuous rise in the level of prices. In the event, the prices continued to rise by double digits in every month of 1992 and 1993, except August of 1992. After considerable volatility in 1994 and 1995, prices stabilized steadily in the following years but did not attain a single annual digit.

The main reasons behind the inflation in the years after liberalization can be traced to a series of supply shocks, which arose from a combination of shortages, monopolistic pricing, financing of budget deficit, excessive issuance of credits, and substantial decline in the value of the ruble in the foreign exchange market. Even though economic agents in Russia hardly had any experience with a monetary policy in market economy, the continuous increases in velocity indicate that they observed that the government permitted the economy to adjust to the earlier supply shocks by an increase in the general level of prices.[22] As a result, each successive shock led to expectations that a similar response would follow in the future. The public, however, took time to adjust its behavior to the new inflationary environment and to protect the real value of their assets and income. These adjustments took numerous forms, but the strong preference for a foreign currency, particularly US dollar, was prevalent. The government took opportunity of the delay in adjustment of money balances by extorting an extraordinary level of inflation tax. More specifically, in 1992 (except January) and 1993, when average inflation was the highest, the average monthly inflation tax amounted to as much as 32.1 and 15.5 percent of GDP, respectively.[23]

Over time, inflationary expectations became deeply embedded. Typically, businesses reacted by demanding higher prices for their good and services. Trade unions, in turn, responded by demanding higher wages and benefits for their members in order to maintain real income in the face of persistent inflation. Hence, most economic agents in Russia came to accept a significant part of inflation as permanent.

It appears that rise in prices was the result of both, inertia and expectations. The former a consequence of a rigid price and wage determination inherited from the previous economic system, and the latter a consequence of considerable depreciation of ruble, itself largely a consequence of a sustained high rate of money supply.[24] In any stabilization attempt, the former is best broken by freezing wages and the latter by anchoring expectations to an effective intermediate target. Since, in the absence of well-developed financial market, economic agents best available proxy for a current inflation rate, except inflation history, is a prevailing level of market exchange rate, the latter seems to be an obvious target. Anchoring exchange rate gives strong and transparent signals that future inflation is likely to be low. This is particularly relevant for transition economies like Russian, where evident shifts in demand for money and unstable velocity reduce the effectiveness of money as a target.

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[22] Similar accommodation, but with various degrees, was also observed in the 3 leading reformers in Central Europe (Poland, Hungary, Czech Republic), at the beginning of transition (Rostowski and Nikolić, 1998).

[23] Inflation tax (IT) is calculated using monthly data given by the *RET* according to the formula: IT = *M2* x (Inflation rate – interest rate). Layard and Richter (1994) calculated that in 1992 for quarters 2 (Q2) to Q4 and 1993 for Q1-Q3, IT was 29.9 and 25 percent, respectively.

[24] Preliminary testing of Pair wise Granger causality test, including inflation, wages, exchange rate and money supply variables up to 6 lags, confirms the previous conjecture. In addition, correlation between inflation and contemporaneous and lagged nominal wages is quite strong (in excess of 50% for up to 6 lags) indicating backward indexation process in Russia. Very similar results are obtained for the correlation between inflation and contemporaneous and lagged exchange rates.

Nevertheless, none of the Russian stabilization programs had a heterodox elements or exchange rate was used as an intermediate target until July 1995. At the latter date, a currency band of 4300 to 4900 rubles for US dollar was introduced, which was later modified into a sort of a crawling peg. While the official programme did not envisage price or wage controls, the Russian authorities applied such measures in autumn 1995 (Bofinger *et al.*, 1997). This was accompanied by the imposition of control over budget deficit, so that stabilization of inflation becomes a realistic and achievable aim, at least in the medium term.

As far as expectations of inflation are concerned, it is clear that the introduction of the currency band, some wage control, and more restrictive monetary and fiscal policies dampened inflationary expectation. This conjecture could be confirmed by the observation that velocity of circulation of *M2* started steadily declining approximately after implementation of stabilization program (Fig. 2.1).[25] Even though, quantity theory assumes that velocity and real growth are stable in the long run, we observe that this may not hold in the short run. [26] The period prior and after stabilization in Russia in July 1995 is a clear case in point. Namely, it is evident that in the years prior to stabilization, inflation was clearly sticky. That is tightening of monetary policy was not followed by an immediate fall of inflation, which is manifested in the rise of velocity. Between February 1992 and Jun 1995, ruble broad money (*M2*) and inflation grew on average by 13.2 and 16 percent, respectively. Thus growth of inflation was for about 3 percentage points greater than the growth of money supply. Possible explanations for the divergence between growth of money and prices include the changes in the demand for real balances, exogenous movements in the exchange rate, wages, the terms of trade, the future stance of monetary policy, rise in inter-enterprise credits and other arrears, remaining administrative prices, and finally measurement errors.[27] The general upward trend of velocity in this period is, however, most likely caused by a gradual improvement of the payment system and the growing skills of the economic agents in preserving their money holding from depreciation.

[25] One has to be aware that, velocity of circulation seems to be overestimated in Russian economy. This is because the GDP is underestimated, given sizable chunk of grey economy. As the grey economy becomes more established and measurable, the measured economy will grow faster than the material economy, which will show velocity falling rather faster than is actually the case. However, the pronounced decline in velocity leaves little doubt that decline is caused not only by the more precise measurement of GDP but even more so by the increase in the average time economic agents hold money balances.

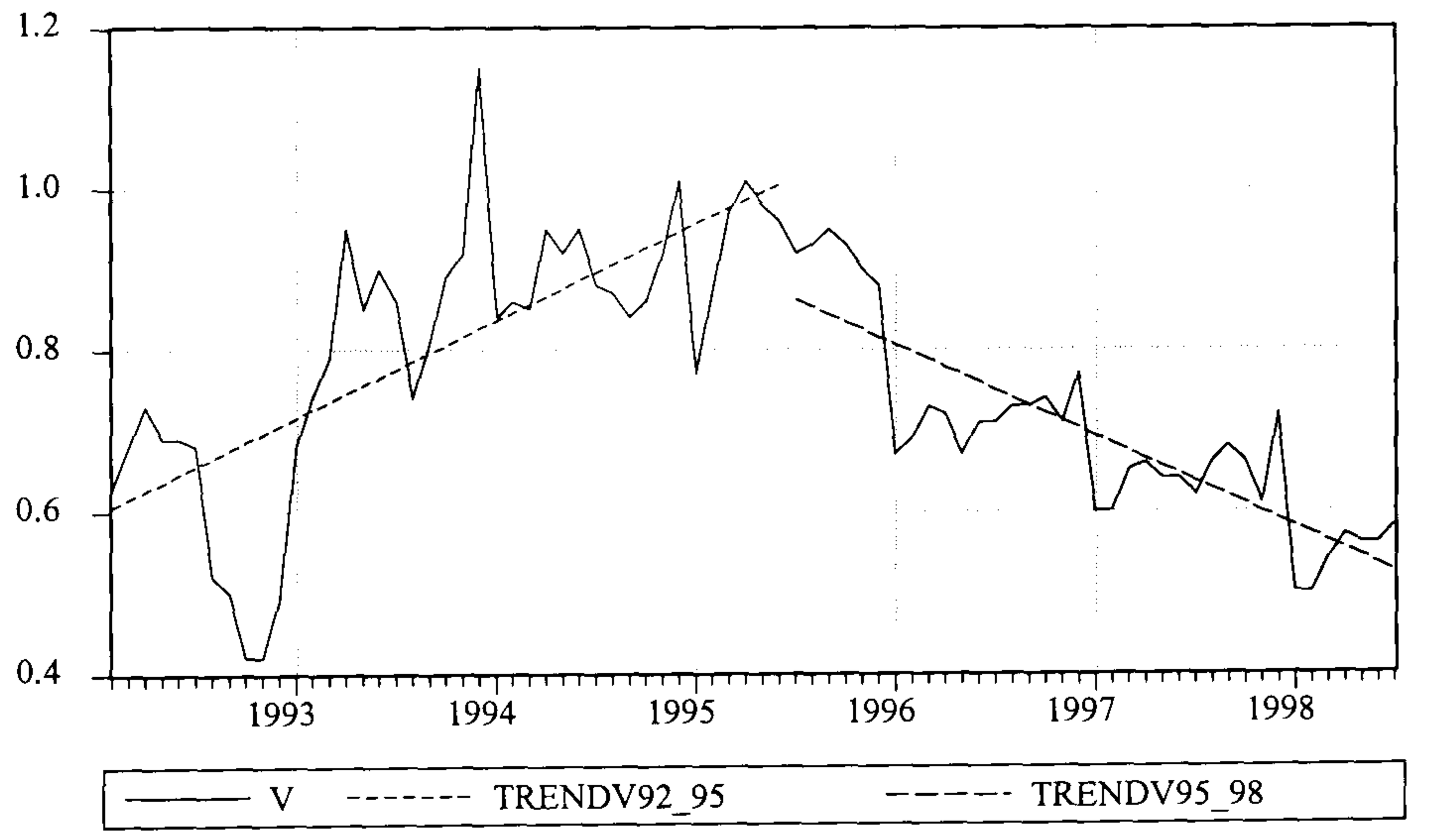
[26] Buch (1999) found that quantity theory holds for Russia in the long run, too.

[27] For the details of factors affecting the underlying demand for money see Anderson and Citrin (1995).

More importantly, the expectations of higher future inflation must have been underlying cause of the increase in velocity. Conversely, the mid 1995 stabilization program dampened inflation expectations so that money supply could rise somewhat without necessarily causing inflation. Moreover, credible tightening of monetary and fiscal policies, establishing positive real rates of return on domestic assets, stable real exchange rate, as well as containment of capital flight, increased confidence about low rate of expected inflation so that velocity declined significantly in the following years. Indeed the average monthly growth of money supply in this period was 2.32 percent while inflation grew only by 1.66 percent, and yet velocity was declining.

Judging by the path and trend in velocity before and after stabilization of June 1995, it appears that inflation was expected to rise in the former and to decline in the latter period (Fig. 2.1). In both cases, economic agents could have used the previous experience with inflation to anticipate its current level within general trends in the two subperiods. Thus, since inflation persistence was strong throughout the entire period, it seems promising to analyze the next-period expected rate of inflation by its recent history.

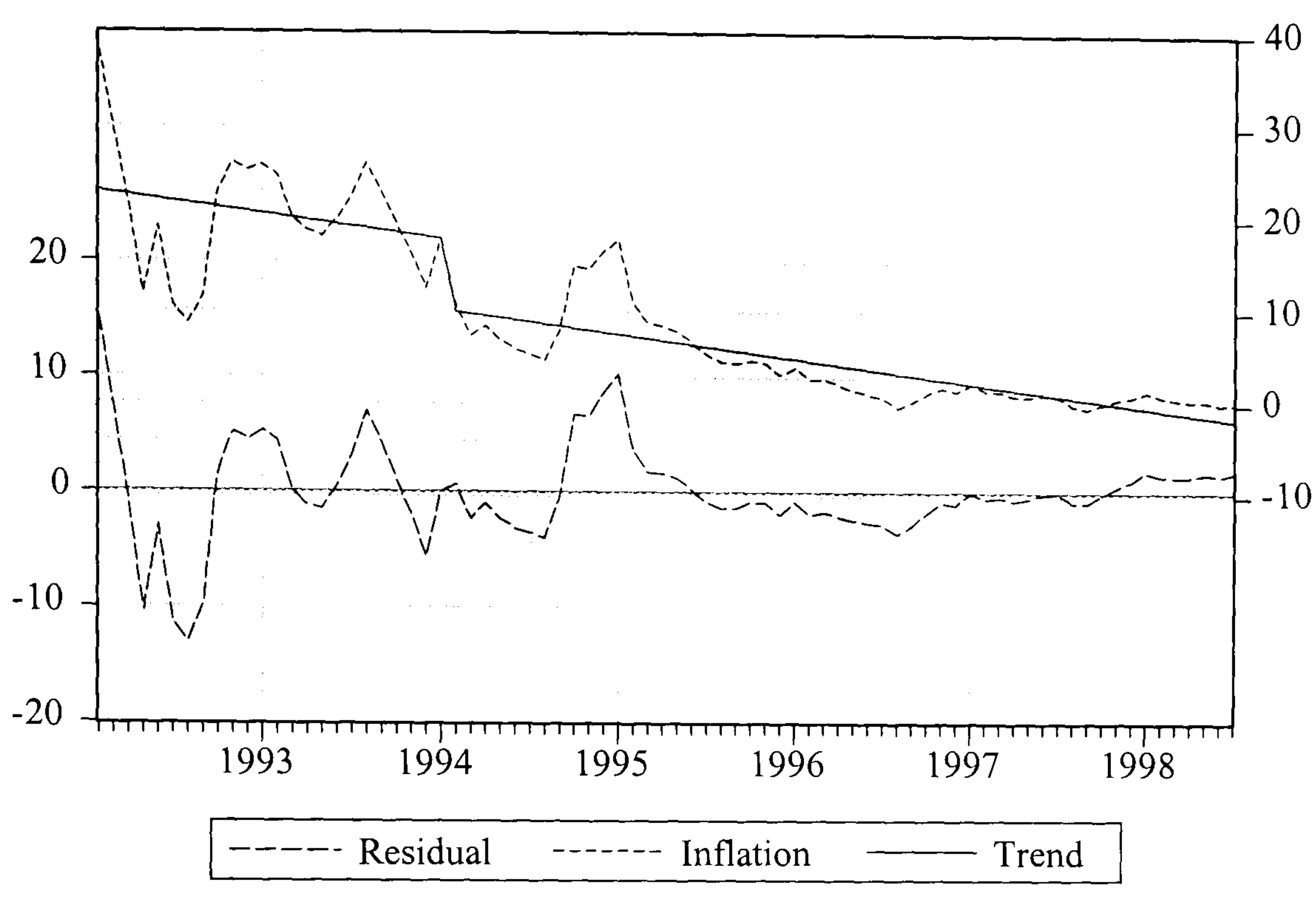
Fig. 2.1 Velocity and Trends in the Sub Periods




## 2.3 Methodology and Model Specification

The data in this study consist of monthly observations of the Consumer Price Index (*CPI*) published by the *RET*, and cover the period between February 1992 and July 1998. The beginning of the period is determined by the month after price liberalization while the end period is dictated by availability of data. Inflation path and its descriptive statistics, as well as a one-time change in the intercept of a trend stationary process, are shown in Fig. 2.2.

Fig. 2.2 Inflation and a One-time Change in the Intercept of a Trend Stationary Process




Series: $\pi$
Sample 1992:02 1998:07
Observations 78

| | |
|---|---|
| Mean | 9.184463 |
| Median | 5.680609 |
| Maximum | 37.99595 |
| Minimum | -0.347032 |
| Std. Dev. | 9.199365 |
| Skewness | 0.925905 |
| Kurtosis | 2.919567 |
| Jarque-Bera | 11.16594 |
| Probability JB | 0.004 |
| $Q_{20}$-stat. | 464.98 |
| Probability $Q_{20}$ | 0.000 |

| | | |
|---|---|---|
| ADF | C,T(4) | -4.4430* |
| PP | C,T(9) | -4.8795* |
| KPPS | C,T(7) | 0.1100* |

*Note*: ADF and PP stand for Augment Dickey-Fuller and Phillips-Perron standard unit root tests, respectively, while KPPS stands for Kwiatkowski, Phillips, Schmidt, and Shin (1992) tests for stationarity.
* (An asterisk) indicates 1 percent level of significance.
C, T() indicates whether a constant term and/or a linear trend has been introduced, respectively, and the maximum lag length of the dependent variable (in parenthesis).

One of the interesting features of the descriptive statistics is that the Ljung-Box tests reject the null hypothesis of zero autocorrelation. This is an indication that series contain a large degree of persistence and perhaps of near unit root process. Nevertheless, standard tests for unit root and the KPSS test for stationarity could not reject the null hypothesis of stationarity, as shown in Fig 2.[28] In addition, the Jarque-Bera normality test shows, that inflation contains a sizable non-normal distribution. While kurtosis of the series is near mesokurtic (2.92), non-normal distribution is most likely caused by the considerable

[28] Nikolić (2000a, 2000b) has also shown that the inflation series, calculated as monthly growth rates of the *CPI* in Russia for the same period, is a trend stationary process with at least one structural break and no seasonal components. Since the break point is assumed to be unknown a priori, the break point that gives the least favourable result for the null hypothesis of a unit root using the test statistic is chosen. In other words, the break point is chosen to minimize the one-sided $t$ statistic. These, as well as all other estimations in this analysis, are done in EViews (v. 3.0).

skewness to the right (0.93). The positively skewed distribution lends credence to the hypothesis that inflation persistence may be driven by relative price adjustment (Coorey *et al.*, 1998). Administered price increases may have supported higher inflation rates in the framework of downward sticky prices.

The underlying assumption in this chapter is Nikolić (2000a) observation that inflation in postcommunist Russia is determined, to a large extent, by its lagged values. That is there is a strong inflationary persistence prevalent in economy. As mentioned above, there is clear evidence that inflation in Russia was sticky in the period prior to June 1995. The idea of stickiness of nominal prices and wages is one of the founding stones of discipline of macroeconomic. It implies among other things, that in the short run, monetary policy affects economic activity rather than prices. Aside probable asymmetry in price and wage stickiness, a major limitation to proxying expectations uniquely through past behaviour is implicit assumption that expectations are not affected by other factors such a major shift in government policy, discrete exchange or terms of trade changes and exogenous shocks. By definition, such expectations are not rational. As long as changes from year to year are smooth, the expectation proxies based solely on past behaviour are likely to work well in terms of explanatory power. However, in the event of sudden and large fluctuations, there is clear risk that the model may perform poorly. Yet despite these shortcomings, it is hypothesized that, in the absence of experience with economizing with real money balances in a market economy, as well as infantilism of financial system, a recent monthly inflation rate was the best available proxy for the current monthly inflation rate for most economic agents in Russia, particularly in the few years following liberalization of prices.

Hence, a very simple autoregressive distributed lag (ADL) model based on the inflation history, which captures inflationary expectations, is given in Eq. 2.3.

$$\pi_t = c_0 + \sum_{i=1}^{X} \alpha_i \pi_{t-i} + e_{0,t} \qquad t = 1, \ldots, T \tag{2.3}$$

where $c_0$ is a constant, $\alpha$s are coefficients of lagged inflation, subscripts $i$ and $t$ denote the lag length and the current time period, respectively, $\pi$ is an inflation rate, $X$ is the optimal lag length of autoregression, and $e_{0,t}$ is the stochastic error term that follows the classical assumptions; namely, it has zero mean, constant variance, and is not autocorrelated (i.e., they are white noise). This model can be thought of as one of the family of models from the Hicks' classical analysis of the factors affecting formation of expectations. [29]

Prior to estimating expectations it is essential to establish an optimal lag length of the autoregression, which amount to determination of an integer $X$ in Eq. 2.3. Among a number of statistical and ad hoc criteria, minimizing the Swartz Criterion (SC) of predictive accuracy is favoured, because it does not only produces the most parsimonious model but it is also asymptotically consistent.[30] Application of the SC, for $X$ up to 15, produced the results presented in Table 2.1.

Table 2.1 Lag Length Selection for the ADL Model of Inflation

| lag | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SC | 5.18 | 5.20 | 5.23 | 5.19 | 5.14 | 4.96 | 4.97 | 5.00 | 4.80* | 4.87 | 4.94 | 5.00 | 5.08 | 4.95 | 5.03 |

*Note:* An asterisk (*) denotes the smallest value of the SC.

## 2.4 Results

After determining the appropriate lag length for the ADLM of inflation we apply the ordinary least squares (OLS) method to Eq. 2.3. However, application of the OLS, which is presented in Table 2.2, does not produce efficient estimates since the error term in the final expression does not seem to follow the classical assumption specified above. More specifically, although diagnostic statistic, presented in the Table 2.2, does not indicate any deficiency of the model, further testing utilizing Lagrange Multiplier (LM), the correlograms of the squared residuals, and Jarque-Berra tests, presented in Tables 3-5 respectively, reveal that the magnitude of residuals appeared to be related to the magnitude of recent residuals. In other words there is autoregressive conditional heteroskedasticity

[29]The other two models in this taxonomic classification are those that capture stochastic shocks (wars, crop failure, major natural disasters, etc.) and structural developments, including monetary, fiscal, incomes and exchange rate policies.

[30]The test statistics is given by the $SC=-2L/n+k\log n/n$ where $k$ is the number of estimated parameters, $n$ is the number of observations, and $L$ is the value of the log likelihood function using the $k$ estimated parameters. In order to select the most appropriate model, we choose the values that minimize the SC. Analogues to other information criteria, the SC is based on minus 2 times the average log likelihood function, adjusted by a penalty function.

(ARCH) in the residuals. Even though, ARCH in itself does not invalidate standard OLS inference, ignoring ARCH effects may result in loss of efficiency.

Table 2.2 OLS Estimates of the ADLM of Inflation

| Variable | Coefficient | t-Statistic | Prob. |
|---|---|---|---|
| $c$ | 0.001 | 0.001 | 0.999 |
| $\pi_{t-1}$ | 1.068 | 9.466* | 0.000 |
| $\pi_{t-2}$ | -0.191 | -1.181 | 0.242 |
| $\pi_{t-3}$ | 0.212 | 1.294 | 0.201 |
| $\pi_{t-4}$ | -0.368 | -2.290* | 0.026 |
| $\pi_{t-5}$ | 0.207 | 1.500 | 0.139 |
| $\pi_{t-6}$ | -0.045 | -0.380 | 0.705 |
| $\pi_{t-7}$ | 0.015 | 0.130 | 0.897 |
| $\pi_{t-8}$ | 0.076 | 0.646 | 0.521 |
| $\pi_{t-9}$ | -0.022 | -0.267 | 0.791 |
| | | | |
| $R^2$ | 0.943 | SC | 4.800 |
| $R^2$ adj. | 0.934 | $F$ | 108.773 |
| S.E. | 2.123 | Prob.($F$) | 0.000 |
| L | -144.445 | D.W. | 2.075 |

Table 2.3 Breusch-Godfrey Serial Correlation LM Test

| Lags | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $F$-statistic | 7.91* | 4.14* | 2.66 | 2.41 | 1.87 | 1.52 | 1.26 | 2.66* |
| Probability | 0.01 | 0.02 | 0.06 | 0.06 | 0.11 | 0.19 | 0.29 | 0.02 |
| Obs. x $R^2$. | 7.28* | 7.68* | 7.53 | 9.01 | 8.87 | 8.84 | 8.73 | 17.72* |
| Probability | 0.01 | 0.02 | 0.06 | 0.06 | 0.11 | 0.18 | 0.27 | 0.02 |

*Note*: An asterisk indicates significance at 5 per cent or better level. The $F$-statistic is an omitted variable test for the joint significance of all lagged residuals. Because the omitted variables are residuals and not independent variables, the exact finite sample distribution of the $F$-statistic under $H_0$ is not known, but we still present the $F$-statistic for comparison purposes. The Obs. x $R^2$ statistic is the Breusch-Godfrey LM test statistic. This LM statistic is computed as the number of observations, times the (uncentered) $R^2$ from the test regression. Under quite general conditions, the LM test statistic is asymptotically distributed as a $\chi^2(p)$.

Table 2.4 Ljung-Box $Q$-statistics for the Squared Residuals

| lag | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-Stat. | 7.68* | 7.71* | 7.73 | 9.22 | 9.88 | 10.19 | 10.37 | 22.89* | 25.55* | 25.61* | 25.61* | 26.37* | 26.69* | 26.73* | 26.82* | 27.08* | 27.09 | 27.09 |
| Prob. | 0.01 | 0.02 | 0.05 | 0.06 | 0.08 | 0.12 | 0.17 | 0.00 | 0.00 | 0.00 | 0.01 | 0.01 | 0.01 | 0.02 | 0.03 | 0.04 | 0.06 | 0.08 |

*Note*: An asterisk indicates significance at 5 per cent or better level.

Table 2.5 Normality Test for the ADL Model

| Skewness | 0.348* |
|---|---|
| Kurtosis | 7.668* |
| Jarque-Bera | 64.028* |
| Probability | 0.00 |

*Note*: An asterisk indicates significance at 5 per cent or better level. The asymptotic standard errors of the skewness and kurtosis coefficients are $\sqrt{(6/T)}$ and $\sqrt{(24/T)}$, respectively, where $T$ is the sample size. An asterisk associated with the coefficients of skewness and/or kurtosis indicates significance and implies that the coefficient exceeds twice its standard error. The Jarque-Bera (JB) normality statistic is distributed as Chi-square with two degrees of freedom.

In order to account for the ARCH effects, we utilize ARCH models proposed by Engle (1982) and Bollerslev (1986).[31] In the first step, an appropriate specification of ARCH model should be determined. To that end we relied on minimizing the SC of predictive accuracy. We looked at the ARCH(1), ARCH(2), and ARCH(3) models and, as it had become a convention, at the GARCH(1,1), GARCH(1,2), GARCH(2,2) and GARCH(2,1) models. According to Bera and Higgins (1993), a data set that requires a model of order greater than these presented is very rare. The results of the search for the appropriate ARCH model are presented in Table 2.6.

Table 2.6 Choice of ARCH/GARCH Model

| ARCH | 1,0 | 2,0 | 3,0 | 1,1 | 1,2 | 2,2 | 2,1 |
|---|---|---|---|---|---|---|---|
| SC | 4.008* | 4.120 | 4.147 | 4.126 | 4.063 | 4.113 | 4.069 |

*Note*: An asterisk indicates the minimum value of the SC for the given ARCH models

[31] For the sake of brevity, we will use ARCH to refer to both ARCH and generalised ARCH (GARCH) models. For details of ARCH/GARCH modelling see Nikolić (2000a).

After determining the optimal specifications of the ARCH model, we increase efficiency of estimate of Eq. 2.3 by using maximum likelihood method. Hence, the estimates of the ARCH(1) are presented in Table 2.7.[32]

Table 2.7 Maximum Likelihood Estimate of Inflation – ARCH(1,0)

| | Coefficient | z-Statistic | Prob. |
|---|---|---|---|
| $c_0$ | -0.006 | -0.062 | 0.951 |
| $\pi_{t-1}$ | 1.138 | 11.170* | 0.000 |
| $\pi_{t-2}$ | -0.149 | -0.919 | 0.358 |
| $\pi_{t-3}$ | -0.097 | -0.766 | 0.444 |
| $\pi_{t-4}$ | -0.010 | -0.102 | 0.919 |
| $\pi_{t-5}$ | -0.050 | -0.559 | 0.576 |
| $\pi_{t-6}$ | 0.107 | 1.493 | 0.135 |
| $\pi_{t-7}$ | 0.087 | 1.558 | 0.119 |
| $\pi_{t-8}$ | -0.019 | -0.283 | 0.777 |
| $\pi_{t-9}$ | -0.022 | -0.620 | 0.535 |
| | | Variance Equation | |
| C | 0.106 | 0.979 | 0.328 |
| ARCH(1) | 1.609 | 2.824* | 0.005 |

| | | | |
|---|---|---|---|
| $R^2$ | 0.933 | $F$ | 72.498 |
| $R^2$ adj. | 0.920 | Prob. ($F$) | 0.000 |
| S.E. | 2.340 | $Q_{18}$ (sq. res.) | 23.240 |
| L | -112.873 | Prob. $Q_{18}$ | 0.182 |
| D.W. | 2.223 | Skewness | 0.078 |
| $Q_{18}$ (stand. res.) | 13.467 | Kurtosis | 2.158 |
| Prob. $Q_{18}$ | 0.763 | ARCH $LM_8$ | 9.578 |
| Jarque-Bera (JB) | 2.108 | Prob. $LM_8$ | 0.296 |
| Prob. (JB) | 0.349 | RESET $F$ (1) | 0.048 (0.057) |
| | | Prob. $F$ (1) | 0.827 (0.811) |

*Note*: An asterisk indicates significance at 5 per cent or better level.

Diagnostic statistic, presented in Table 2.7, does not reveal any deficiency of the ARCH(1) model of inflation in Russia for the given period. The fit of the model is reasonably good and there is no sign of autocorrelation in the residuals. Although the only

[32] The hypothesis that, in addition to lagged inflation rate, the expectation of future inflation also depend on its variability, which is defined as the absolute change in the rate of inflation, is also tested. However, the coefficient of variability of inflation is not found significant.

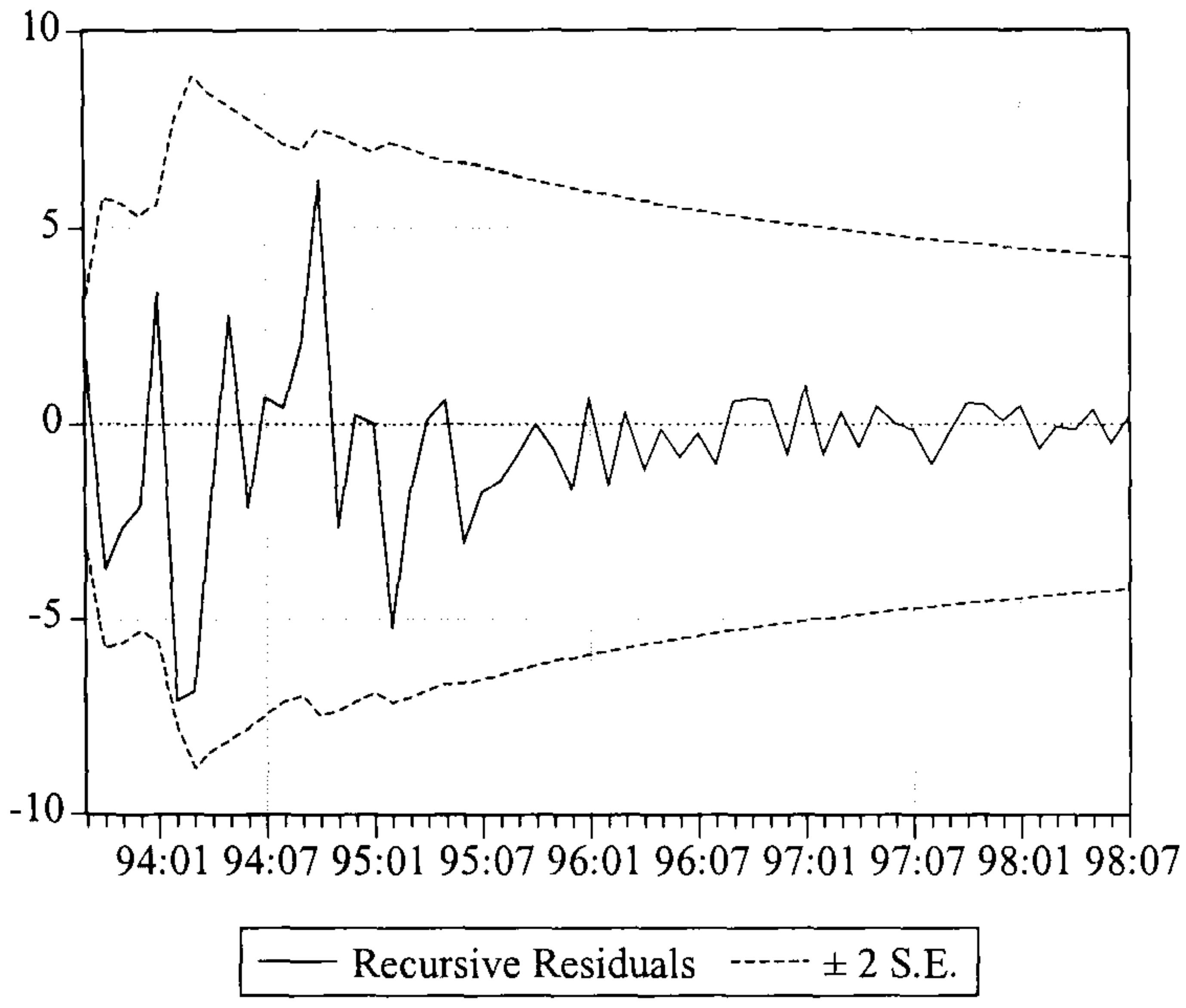
significant lag in the autoregression appears to be lag one, the Wald test rejects the null hypothesis that the coefficients of the rest of the lags are jointly zero.[33]

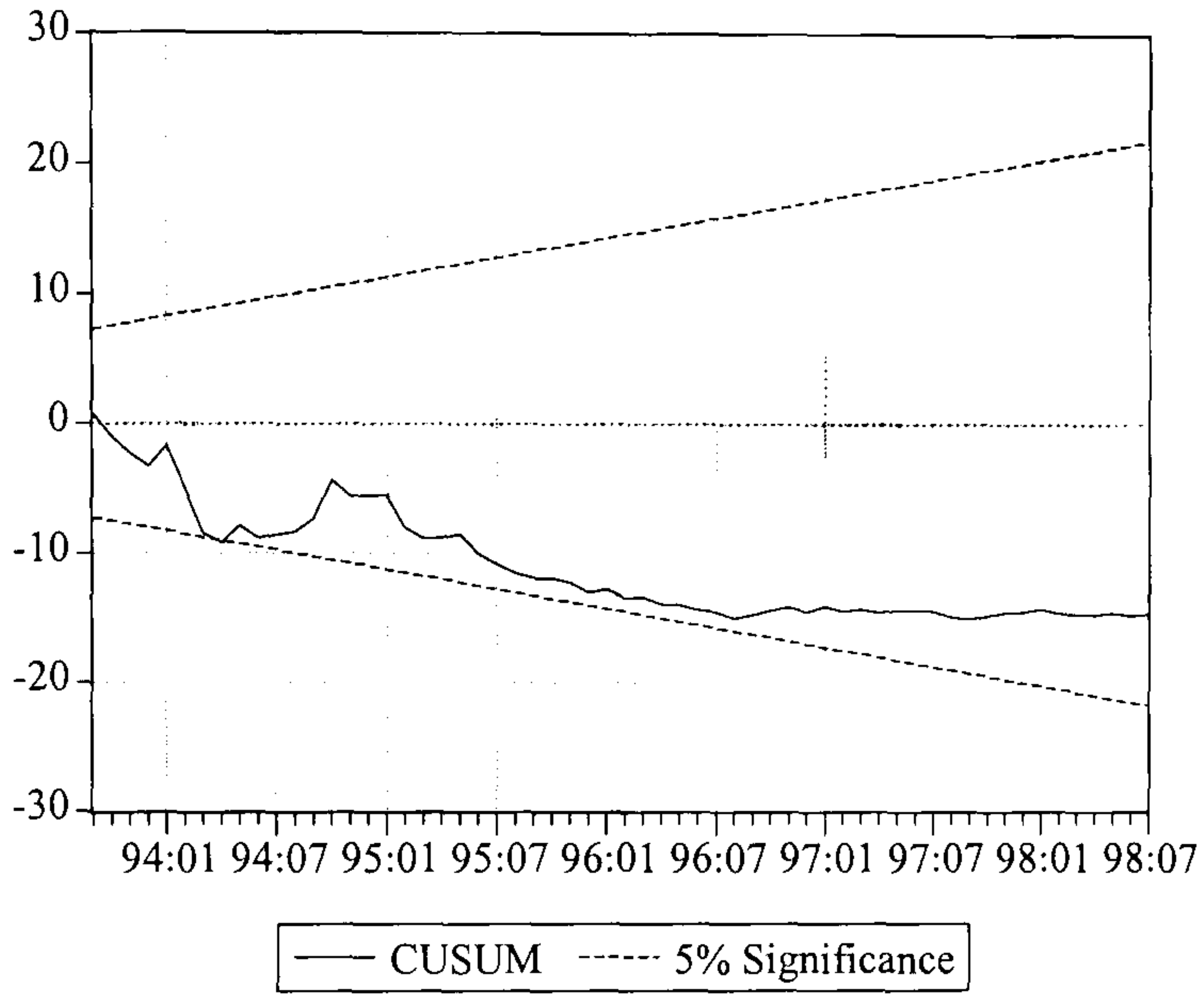
Given enormous changes that took place in Russia and numerous structural shifts during stabilization period, it would be interesting to examine whether the parameters of our model, presented in Table 2.7, are stable across various sub-samples of our data. The majority of stability tests, however, cannot be performed on the models estimated by likelihood method. Since most of these tests can be used with least squares and two-stage least squares regressions we subjected the OLS estimates of Eq. 2.3, given in Table 2.2, to plethora of recursive least squares stability tests. The tests include: recursive residuals test (RRT), CUSUM test based on the cumulative sum of the recursive residuals, CUSUM of square test, one step forecast test (O-SFT), N-step forecast test (N-SFT), and finally the recursive OLS coefficient test (ROLSCT). As shown in Figs. 2.3 and 2.4, all of the stability tests, except the CUSUM square test, could not reject the null hypothesis of no structural break in the data at the conventional level of significance.[34]

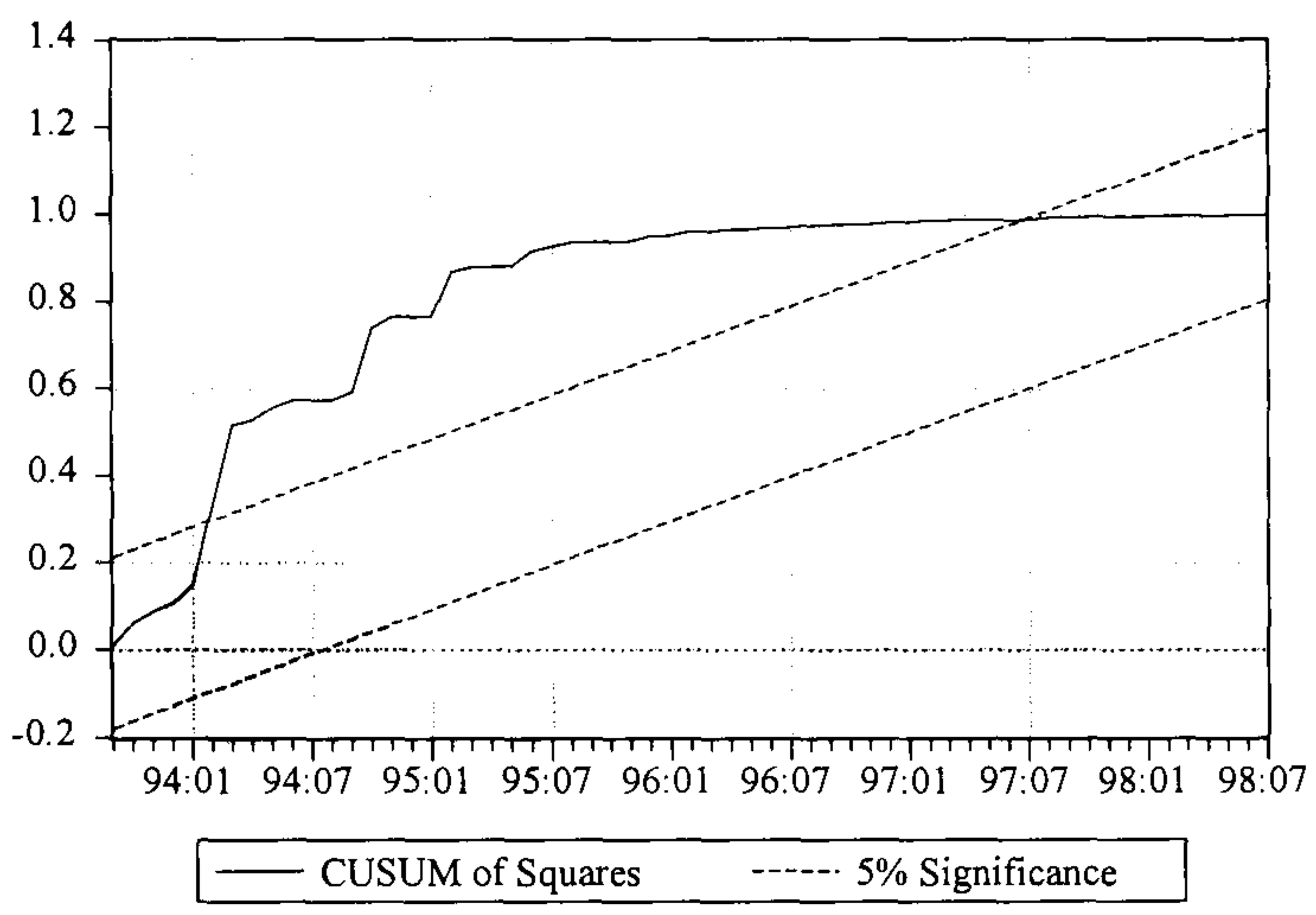
[33] *F*-statistics = 0.7649 (probability = 0.6347); Log likelihood ratio (*LR*) = 24.7217 (probability = 0.00173).

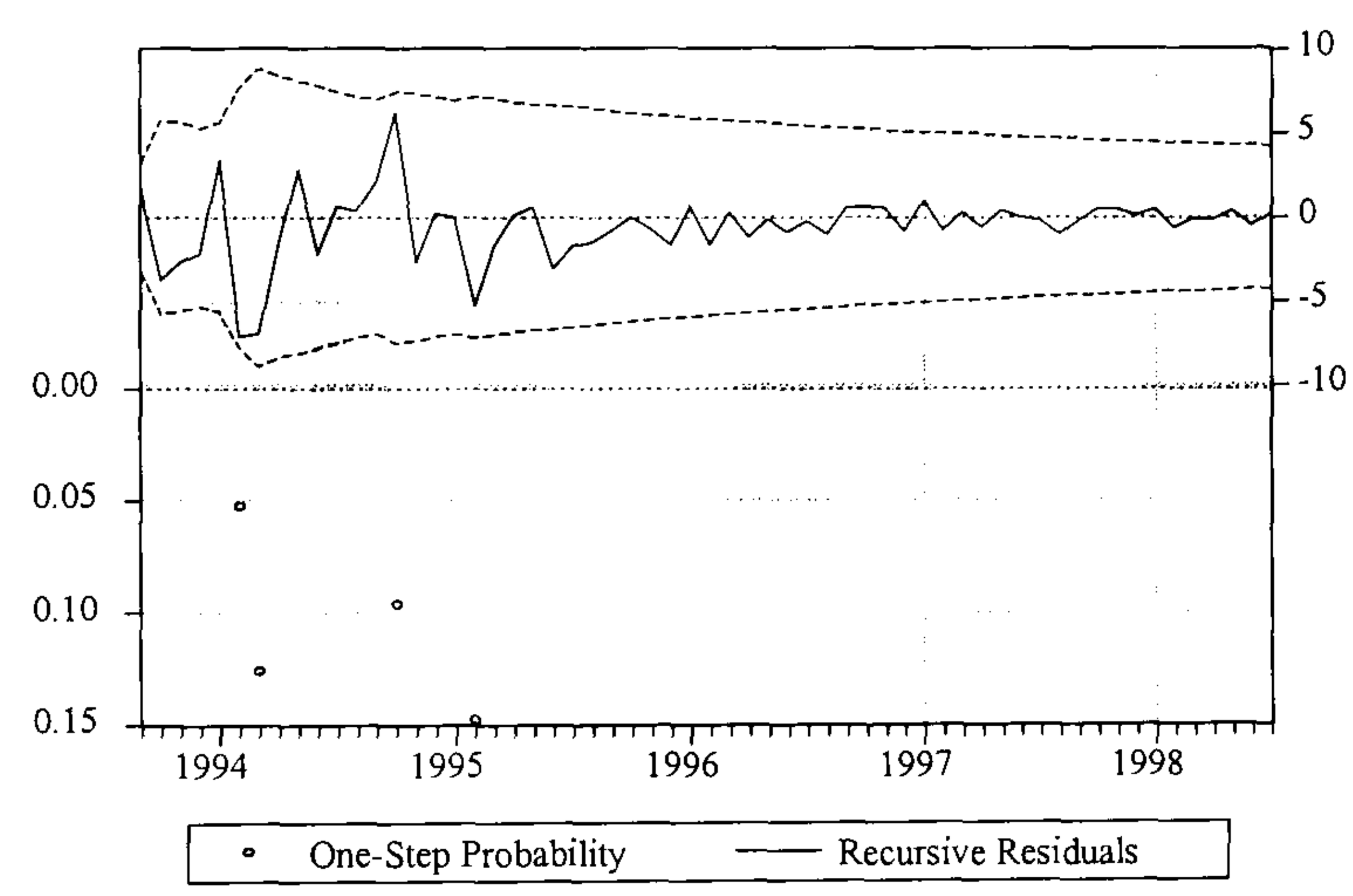
[34] The conventional level of significance throughout the paper is 5 percent.

Fig. 2.3 Tests on Parameter Stability of the ADL Model of Inflation



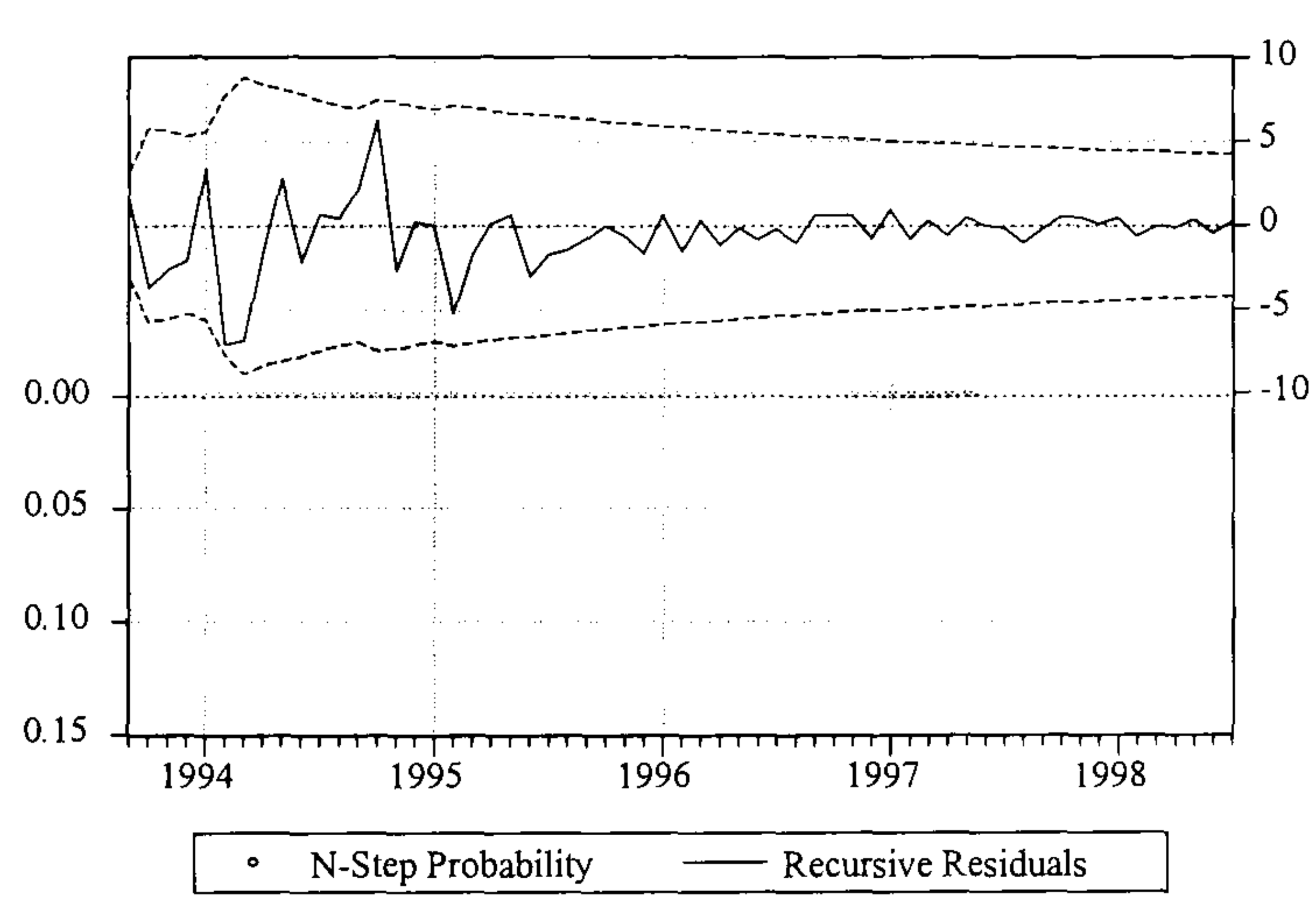
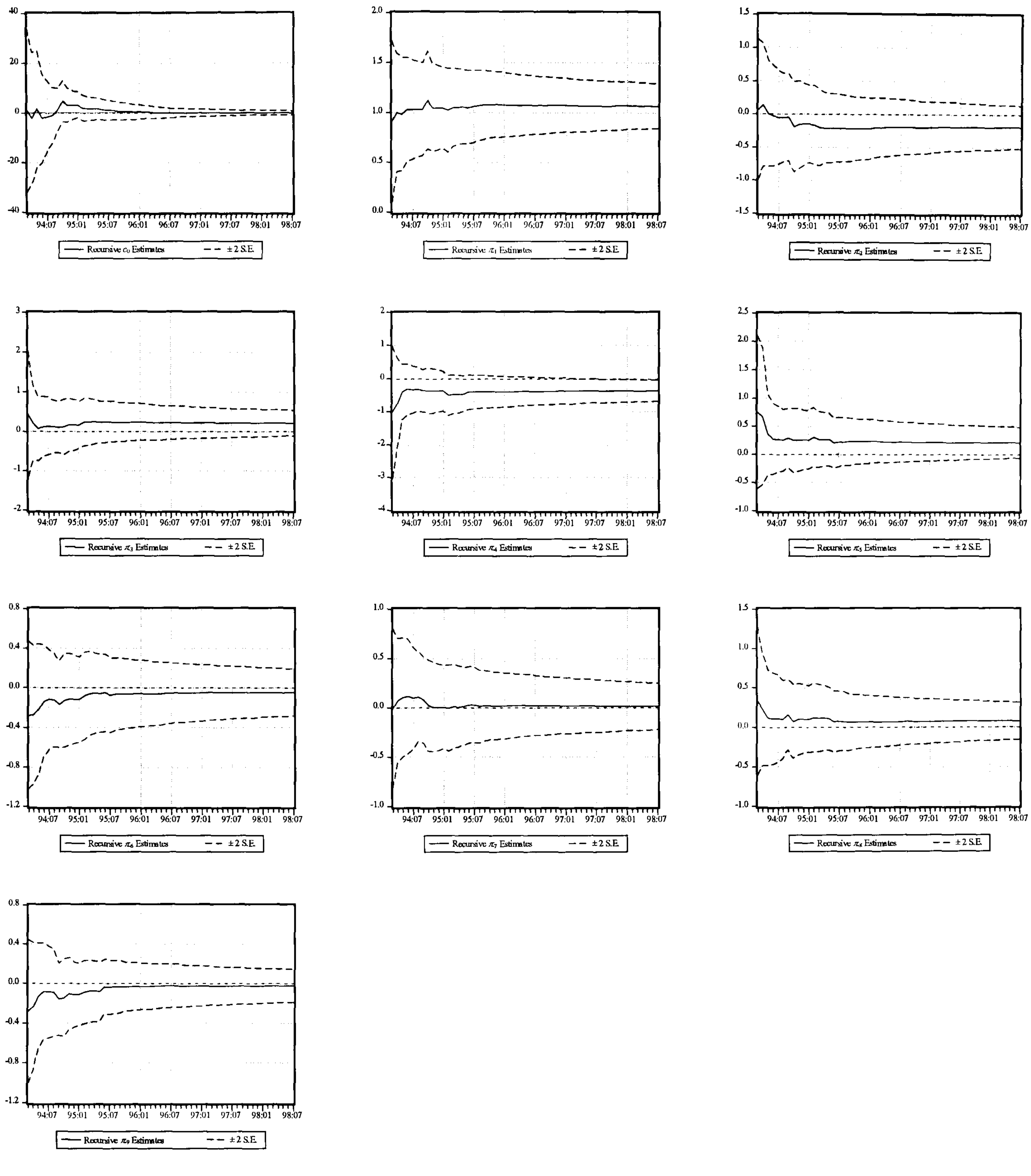



Fig. 2.4 Recursive Coefficients Estimates of the ADL Model of Inflation



Specifically, in contrast to the results of the rest of stability test, the plot of the CUSUM of square test points that at the beginning of 1994 the parameters of the equation change significantly. Aided by the plot of the O-SFT, we can see that indeed the period of about one year between early 1994 and early 1995 is the least successfully captured by the equation. This particular period is characterized by the uncertainty brought about by the stop and go policies of various stabilization efforts as well as the exchange rate collapse on "Black Tuesday" in October 1994. Thus the performance of the model in this period is hardly surprising, particularly in light of the fact that we have already established that inflation series has a structural break at the beginning of the 1994 period. In order to account for the potential structural break in the model, one could include a dummy variable for structural break as well as a dummy for the external shock of October 1994. Such model would improve the fit for about 3-percentage point, but would inevitably be less parsimonious and it would require further diagnostic testing. Nevertheless, the CUSUM square test indication of a structural break could not be supported by any other stability test mentioned above.

In particular, since recursive residuals in the RRT fall inside the plus minus two standard error band, there is no sign of instability of parameters of the equation. Similarly, the lower portion of the plot (left vertical axis) of the O-SFT shows the probability values for those sample points where the hypothesis of parameter constancy would be rejected at the 5, 10, or 15 percent levels. While this plot can help us spot the periods when our equation is least successful, it shows that parameter constancy could not be rejected at the 5 percent level. By the same token, the N-SFT, which uses the recursive calculations to carry out a sequence of Chow Forecast tests, does not indicate instability of parameter of the equation.[35] Much of the same applies to the CUSUM, which is based on the cumulative sum of the recursive residuals. Since the cumulative sum does not go outside the area between the two 5 % critical lines, there is no indication of parameter instability. Finally, the RCE enables us to trace the evolution of estimates for any coefficient as more and more of the sample data are used in the estimation. Not only the plots of selected coefficients do not go beyond its own two standard error bands, but also there are no dramatic jumps in the plot except some mild one at the beginning of the period, which are likely to be reflecting the limited number of observation used to estimate them at the start of the recursion. As a matter of fact, the plots of individual coefficients are remarkably smooth and linear. In addition, Ramsey's (1969) regression specification error test (RESET) does not indicate any deficiency of the model.

[35] In contrast to the single Chow Forecast test, this test does not require the specification of a forecast period— it automatically computes all feasible cases, starting with the smallest possible sample size for estimating the forecasting equation and then adding one observation at a time.

## 2.5 Alternative Modelling

An alternative and more parsimonious method of modelling time series, like inflation rate in our sample, is a popular Box-Jenkins method, technically known as the autoregressive integrated moving average (ARIMA). The ARIMA models encompass the generic family of models associated with the broad term 'adaptive expectations hypothesis'. The emphasis of these new forecasting tools is not constructing a single or simultaneous equation(s) models but on analyzing probabilistic, or stochastic, properties of economic time series on their own under the philosophy 'let data speak for themselves'. Hence, the conditions for optimal forecasts can be generalized to include the nature of the shocks, leading to the general proposition that forecasts should be revised by a weighted average of all previous errors and not just by a fraction of the last one. In this way, the ARIMA models provide a general framework for the most efficient forecast of inflation, when no information other than past inflation is considered (Feige and Pearce, 1976). Given this, ARIMA models appear to be the most appropriate for our analysis. Since our time series is found to be stationary i.e., it does not need to be integrated, we can model Eq. 2.3 as an autoregressive (AR), or moving average (MA), or combination of these two (ARMA) processes.

The first step of our analyses is to identify an approximate structure of the model by finding out appropriate values of the AR term ($p$) and the MA ($q$) term. To that end, we utilize the chief tools in identifications: autocorrelation function (ACF), partial autocorrelation function (PACF) and the resulting correlograms. This analysis indicates that both the ACF and the PACF decay exponentially and both have significant spikes.[36] Hence, the likely model is to be an ARMA process. Significant spikes at lags 1 and 6 in the PACF indicate AR(6) process while quite a few significant lags in the ACF indicate a complex MA process. In order to identify the optimum model we again utilize the SC of predictive accuracy. To that end we tested the AR(6) in combination with various MA terms. With a help of ACF, PACF and the SC, the tentative identified model turned to be ARMA(6,1).

Having tentatively identified the appropriate $p$ and $q$ terms in our ARMA model, we then estimated parameters of the AR and MA terms included in the model. The results of

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[36] The graphs of the correlogram and partial correlogram are not presented but could be obtained from the author upon a request.

this estimate, obtained by the OLS, as well as the diagnostic statistics, are presented in Table 2.8.

Table 2.8 ARMA(6,1) Model of Inflation

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $c_0$ | 3.506 | 8.754 | 0.400 | 0.690 |
| AR(6) | 0.067 | 0.056 | 1.204 | 0.233 |
| AR(1) | 0.878 | 0.066 | 13.349* | 0.000 |
| MA(1) | 0.337 | 0.124 | 2.708* | 0.009 |
| | | | | |
| $R^2$ | 0.913 | Mean dep. var. | | 8.128 |
| $R^2$ adj. | 0.909 | S.D. dep. var. | | 8.318 |
| S.E. | 2.504 | S.C. | | 4.854 |
| L | -166.187 | $F$ | | 238.536 |
| D.W. | 2.061 | Prob. $F$ | | 0.000 |
| $Q_{20}$-resid. | 19.452 | $Q_{20}$-resid. sq. | | 21.178 |
| Prob. $Q_{20}$ | 0.303 | Prob. $Q_{20}$ sq. | | 0.219 |
| Inverted AR Roots | 0.96 | .45 -.46i | .45+.46i | -.22 -.52i |
| | -.22+.52i | | | -0.54 |
| Inverted MA Roots | | | | -0.34 |

After estimation of the ARMA(6,1), model we applied diagnostic tests in order to check whether it was specified correctly. We assumed that the random error terms in the actual process are normally distributed and independent. It follows that, if the model has been specified correctly, the residuals from the model should resemble white noise process. None of the individual autocorrelation and partial autocorrelations came out to be significant. Similarly, Box-Pierce $Q_{20}$ statistics of residuals and square residuals, presented in Table 2.8 also came out to be insignificant. The reciprocal roots of the AR and MA polynomials have modulus no greater than one.[37] Hence, white noise residuals obtained by the model indicate acceptance of the model.

However, in testing for stability of parameters of the model, the Chow Break Point (SBT) test indicates that there is a structural break at the beginning of 1994.[38] This finding came as no surprise, since we already established that inflation series had a structural break in this point of time. Subsequently, we modified the ARMA(6,1) model to take account of

[37] If $p$ has a real root whose absolute value exceeds one or a pair of complex reciprocal roots outside the unit circle (that is, with modulus greater than one), it implies an explosive autoregressive process. Conversely, if $q$ has reciprocal roots outside the unit circle, we say that the MA process is noninvertible, which makes interpreting and using the MA results difficult.

[38] $LR$=26.4416, probability=0.000026.

the structural break (*SBFEB94*).[39] In addition, following Nikolić (2000a), a dummy variable *DO94* is included in the model to account for exogenously induced inflation that occurred in 1994 as result of the exchange rate crises of October 1994 (Black Tuesday).[40] Hence, the following model is estimated:

$$\pi_t = c_1 + \zeta_1 \mathrm{AR}(1) + \varpi_1 \mathrm{AR}(6) + \theta_1 \mathrm{MA}(1) + \omega_1 SBFEB94 + \psi_1 DO94 + e_{1,t} \tag{2.4}$$

where $c_1$ is a constant, $e_{1,t}$ is an error term with classical properties described above, and $\zeta_1$, $\varpi_1$, $\theta_1$, $\omega_1$, and $\psi_1$, are the coefficients of the respective variables described above.

Estimates of the Eq. 2.4 and accompanying diagnostics statistics does not reveal any deficiency of the model, as shown in Table 2.9 and Fig. 2.5. The fit of the model is good and the model seems to be predicting turning points reasonably well.

---

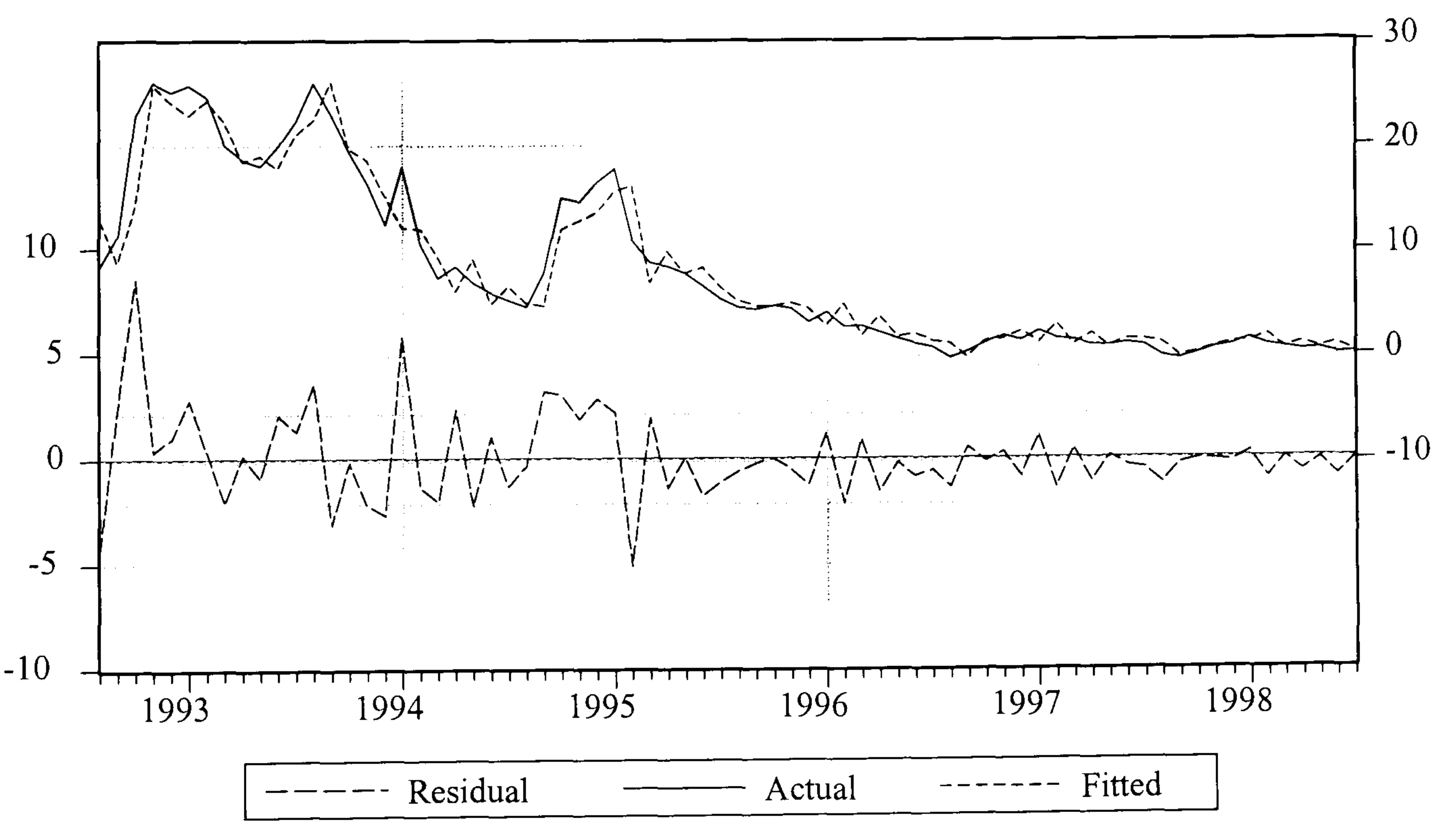
[39] Dummy variable *SBFEB94* = 1 after January 1994 and 0 otherwise.

[40] The dummy variable, *DO94*, takes a value of 1 for October 1994 and zero otherwise. At the beginning of October 1994, the Central Bank of Russia (CBR) lost control over the exchange rate and with reserves running low, was unable to prevent Black Tuesday on October 11 when the ruble (R) to dollar ($) exchange rate fell by 28%, jumping from R3, 000 to almost R4, 000 in one day. For the entire month of October, the exchange rate jumped from R2, 361/$ to 2,994/$, which is equivalent to a month-to-month nominal depreciation of 26.8% (*RET*, 1994). While there have been many financial and other crises in Russia during transition, Nikolić (2000a) found that, the magnitude of the Black Tuesday crises, if not taken into account, renders a simple ADL model of money price relationship to be unstable. A similar exogenous shock, but with a greater magnitude, seems to have taken place in August 1998. It would be necessary to take this into account in a similar manner if the period after July 1998 were modelled.

Table 2.9 ARMA(6,1) Estimate of Inflation Including Structural Break

| *Variable* | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| $c_1$ | 14.391 | 3.972 | 3.624* | 0.001 |
| SBFEB94 | -9.661 | 1.971 | -4.901* | 0.000 |
| DO94 | 2.515 | 1.093 | 2.301* | 0.025 |
| AR(1) | 0.779 | 0.080 | 9.725* | 0.000 |
| AR(6) | 0.103 | 0.063 | 1.629 | 0.108 |
| MA(1) | 0.588 | 0.114 | 5.161* | 0.000 |
| | | | | |
| $R^2$ | 0.939 | Mean dep. var | | 8.128 |
| $R^2$ adj. | 0.934 | S.D. dep. var | | 8.318 |
| S.E. | 2.138 | S.C. | | 4.627 |
| L | -153.730 | $F$ | | 201.801 |
| D.W. | 2.074 | Prob. $F$ | | 0.000 |
| $Q_{20}$ | 16.078 | $Q_{20}$ sq. | | 17.743 |
| Prob. $Q_{20}$ | 0.518 | Prob. $Q_{20}$ sq. | | 0.405 |
| ChowFT$_{1995:06}$LR | 18.582 | RESET$_1$ | | 1.403 |
| Prob. ChowFT | 0.997 | Prob. RESET$_1$ | | 0.236 |
| Inverted AR Roots | 0.93 | .47 -.52i | .47+.52i | -.25 -.56i |
| | -.25+.56i | | | -0.6 |
| Inverted MA Roots | | | | -0.59 |

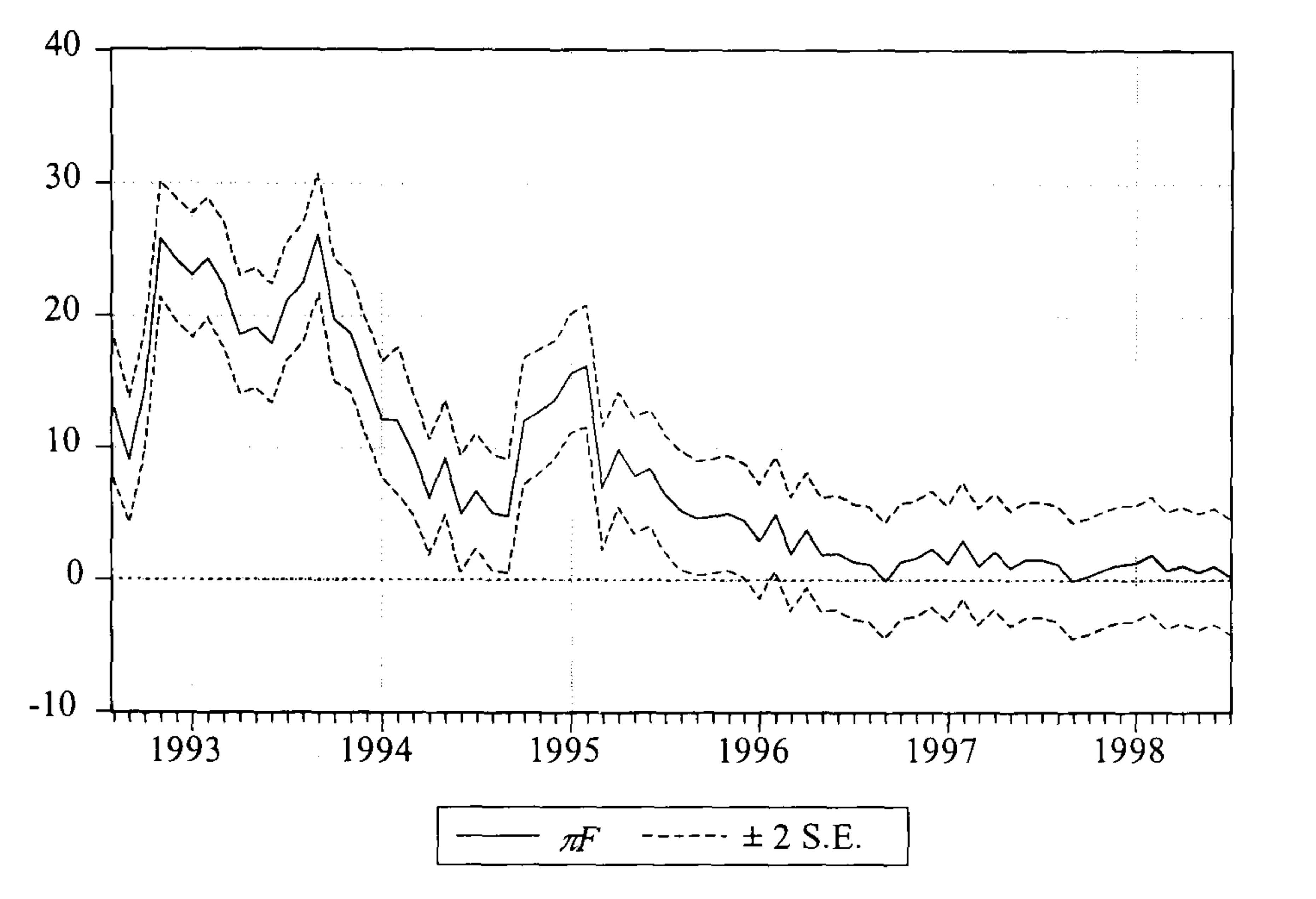
Fig. 2.5 Actual and the ARMA(6,1) Fitted Inflation



## 2.6 Forecasting

Perhaps the most important use of ARMA models is to forecast future values of the sequence of a dependent variable. Since our objective is to examine the formation of inflation expectation based on its own history, it would be interesting to test the performance of our ARMA(6,1) model. This is done by applying static forecasting, or one-step-ahead forecasts, and presented in the Fig. 2.6.

Fig. 2.6 Static Forecast of ARMA(6,1) Model With the Structural Break




Forecast: $\pi F$

Actual: $\pi$

Sample: 1992:08 1998:07

Include observations: 72

| | |
|---|---|
| Root Mean Squared Error | 2.0466 |
| Mean Absolute Error | 1.4205 |
| Mean Abs. Percent Error | 78.594 |
| Theil Inequality Coefficient | 0.0896 |
| Bias Proportion | 0.0000 |
| Variance Proportion | 0.0548 |
| Covariance Proportion | 0.9452 |

The first two forecast error statistics depend on the scale of the dependent variable. These can be used as a relative measure to compare forecasts for the inflation series across different models; the smaller the error, the better the forecasting ability of that model according to that criterion. The remaining two statistics are scale invariant. The Theil (1961) inequality coefficient always lies between zero and one, where zero indicates a perfect fit. The mean squared forecast error can be decomposed as: the bias proportion, which tells us how far the mean of the forecast is from the mean of the actual series; the variance proportion, which tells us how far the variation of the forecast is from the variation of the actual series; and the covariance proportion, which measures the remaining unsystematic forecasting errors.[41]

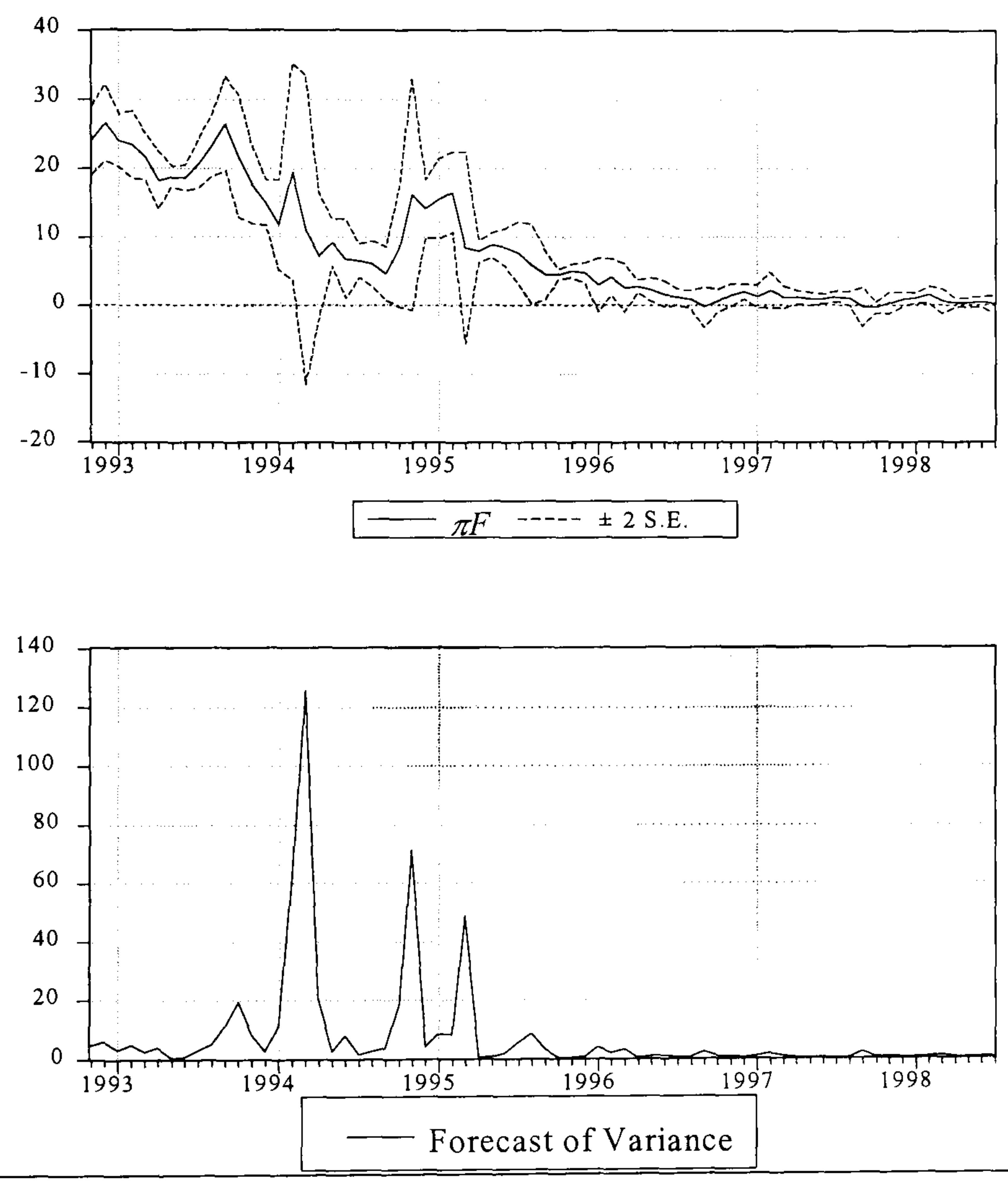
In our model, the bias proportion is extremely small, indicating that the mean of the forecasts does a decent job of tracking the mean of the dependent variable. In other words,

[41] Note that the bias, variance, and covariance proportions add up to one.

since the extent to which average values of simulated and actual series deviate from each other is negligible, there is no indication of systematic error in the model. Furthermore, somewhat larger, but still very small, the variance proportions indicates that most of the bias is concentrated on the covariance proportions. Hence, our one-step ahead forecast of ARMA(6,1) model of inflation seem to perform reasonably well.

We also applied one-step ahead forecast on the estimated ARCH(1) model described above. The procedure includes computing static forecast of the mean, its forecast standard error, and the conditional variance. The upper part of the Fig. 2.7 shows the forecast of the dependent variable from the mean equation together with the two standard deviation bands. The lower part of the graph is the forecast of the conditional variance.

Fig. 2.7 Static Forecast of ARCH(1,0) Model of Inflation




Forecast: $\pi F$

Actual: $\pi$

Sample: 1992:11 1998:07

Include observations: 69

| | |
|---|---|
| Root Mean Squared Error | 2.1265 |
| Mean Absolute Error | 1.3832 |
| Mean Abs. Percent Error | 64.981 |
| Theil Inequality Coefficient | .0929 |
| Bias Proportion | 0.0109 |
| Variance Proportion | 0.0007 |
| Covariance Proportion | 0.9884 |

The variance shown in the lower graph (Fig. 2.7) appears to be declining over this forecast horizon but it has at least 3 notable peaks. As expected, the largest peak is at the point of the structural break in inflation series as discussed above. The next largest peak in the forecast of variance is unsurprisingl in October 1994 at the time of exchange rate crises as explained above. Finally, third significant peak in the forecast of variance in early 1995 perhaps indicates the inflation shock related to a significant liberalization of the energy prices in this period. Since the ARCH term is not close to one, the volatility shocks, although notable, are not for the most part persistent and the forecasts of the conditional variance converge to the steady state reasonably fast.

In conclusion about forecasting, it seems that both models give good static forecasts of inflation.

### 2.7 Rationality of Expectations

Under rationality, the long-run response of expected inflation to the actual rate of inflation should be equal to one, as economic agents cannot systematically be fooled (Muth, 1961). In other words, expectations of agents are said to be rational if they coincide with the true mathematical expectations conditioned on all relevant information available at the time forecast was made. Two types of tests are used to test the rationality of expectations: test for unbiasedness and test for efficiency. The former tests whether forecasts are unbiased estimates of the actual inflation rate, and the latter, whether forecasts incorporate all available relevant information. The latter typically distinguishes between 'weak form efficiency' and 'strong form efficiency'. The weak form efficiency test implies testing whether the expectations error can be explained by previous periods expectations errors. Conversely, strong form efficiency (orthogonality) implies that economic agents make efficient use of all available information in forming expectations of the inflation rate.

In order to analyze the underlying principle behind each of the test of rationality more formally, let $\pi_t$ be the inflation rate at time $t$ and $\pi^e_t$ be the rate of inflation during period $t$ expected by agents at the end of period $t$-1, and let $I_t$ contain all relevant information at the end of $t$-1. If $\pi^e_t$ is the rational expectation (RE) of $\pi_t$, then

$$\pi^e_t = E\,[\pi_t \mid I_t] \tag{2.5}$$

where $E$ is the conditional operator. Eq. 2.5 implies that $\pi^e_t$ is an unbiased predictor of $\pi_t$, which can be tested by running the regression

$$\pi_t = c_2 + \alpha\, \pi^e_t + e_{2,\,t} \tag{2.6}$$

and testing the joint hypothesis that $(c_2, \alpha) = (0, 1)$. Acceptance of the null hypothesis would be consistent with rationality.

However, tests based on Eq. 2.6 are rather weak, since RE hypothesis imply much more than unbiasedness. For expectations to be rational, they must include all relevant information available at the time they are formed. This information is likely to include the past history of inflation, previous period inflation forecasts and thus forecast errors, and most probably other variables that may influence inflation i.g., money supply, unemployment, fiscal variable etc. Typically, this is the objective of the tests for efficiency.

The weak form efficiency test implies testing whether the expectations errors can be explained by previous periods expectation errors. Let $\phi_{j,t} = \pi_t - \pi^e_t$ represent measured forecast error, where $j$=1 for ARCH(1,0) and $j$=2 for ARMA(6,1) model presented above. The hypothesis of zero correlation and non-significant zero mean can be tested by regressing $\phi_{j,t}$ on lagged values of itself. That is we estimate

$$\phi_{j,t} = \sum_{i=1}^{K} \beta_i \, \phi_{j,t-1} + e_{3,t} \tag{2.7}$$

and test the null hypothesis $H_0{:}\beta_i = 0$, $i = 1, \ldots, K$ for a range of choices $K$. Assuming that past price information is readily available and clearly relevant (i.e., $\pi_{t-i}$ is contained in the $I_{t-1}$ for $i \geq 1$), an obvious test of rationality is that $\phi_{j,t}$ cannot be correlated with lagged rates of inflation. The Eq. 2.8 is estimated and the following null hypothesis is tested: $H_0$: $\gamma_i = 0$, $i = 1, \ldots, K$ for a range of choices $K$.

$$\phi_{j,t} = \sum_{i=1}^{K} \gamma_i \, \pi_{t-i} + e_{4,t} \tag{2.8}$$

Strong form efficiency or orthogonality implies that economic agents make use of all available information in forming expectation about inflation rate. This hypothesis can be tested by examination for lack of correlation between forecast errors ($\phi_{j,\ t}$) and other variables contained in $I_{t-1}$.[42]

$$\phi_{j,\ t} = z'_{t-i}\delta + e_{5,\ t} \tag{2.9}$$

where $z'_{t-i}$ is a vector of information variables dated $i$-1 or earlier (extended broad money supply, $m2x$, in our case),[43] $\delta$ is a vector of coefficients, and the null hypothesis (consistent with rationality) $H_0{:}\delta = 0$, $i = 1$ is tested.

Each of the tests described above tests for violation of rationality in a particular direction. The tests give various and interesting assessment of rationality and they are therefore presented separately. Each test is performed on both, ARCH(1) and ARMA(6,1) models. However, forecast error series are required to be stationary in their regressions. Hence, both series were tested for stationarity and found to be stationary at the conventional 5 percent level of significance. The results of the standard unit root tests, such as ADF and PP, are presented in Table 2.10.

Table 2.10 Unit Root Tests for $\phi_1$ and $\phi_2$

| | $\phi_1$ | $\phi_2$ |
|---|---|---|
| ADF | -6.57* | -4.82* |
| Specification[a] | 0, 0(1) | 0, 0(2) |
| LM1, (LM4)[b] | 1.98, (2.82) | 0.35, (6.25) |
| PP | -9.26* | --9.26* |
| Specification[a] | 0, 0(3) | 0, 0(3) |

*Note*: * (**) indicates 1 (5) percent level of significance.

[a]Indicates whether a linear trend (T) and/or a constant term (C) has been introduced and the maximum lag length of the dependent variable (in parenthesis).

[b]Chi-square – values of an LM test on 1[st] (4[th]) order autocorrelation. Critical values at the 5 percent level of confidence are 3.84 (9.49).

[42] An alternative test for the hypothesis of strong rationality can be performed by adding variables contained in $I_{t-1}$ in addition to the lagged expectation errors, to the right side of Eq. 2.7 and testing for the joint significance (Pesaran, 1987).

[43] The choice of variable(s) contained in $I_{t-1}$ would depend of the available information and the costs to acquire and process them. It follows that rational agents will set the marginal costs of acquiring and processing information to be equal to the benefits of acquiring them. We assumed that one of the most relevant variables to influence inflation is broad money supply ($m$2x) as in Nikolić (2000a). If it turns out that this variable does not systematically influences expectation of inflation, than alternative variable would be included in $I_{t-1}$ and consequently tested. Conversely, if expectations turn not to be rational there is no point in including other variables in the set for our purpose.

Diagnostic statistics, presented in Table 2.11, clearly demonstrates that null hypothesis of coefficients restriction in Eq. 2.6 could not be rejected in either of the models. Hence, expectations of inflation are unbiased in both of the models.

Table 2.11 Wald test statistics of the coefficients restrictions: $(c_2, \alpha) = (0, 1)$

| | ARCH(1,0) | ARMA(6,1) |
|---|---|---|
| $F$-statistic | 0.735 | 0.428 |
| Probability | 0.484 | 0.654 |
| Chi-square | 1.469 | 0.856 |
| Probability | 0.480 | 0.652 |

Similarly, Wald test for the null hypothesis, $H_0$: $\beta_i = 0$, $i = 1$, in Eq. 2.7, as well as Lagrange multiplier (LM) tests for zero correlation in forecast errors, could not reject the notion of rationality of expectation of inflation, either. [44]

Table 2.12 Tests for Zero Correlation and Non-significant Zero Mean

| | ARCH(1,0) | | ARMA(6,1) | |
|---|---|---|---|---|
| LM 1 (4) | 0.000 | (3.008) | 0.345 | (6.249) |
| Probability 1(4) | 1.000 | (0.556) | 0.557 | (0.181) |
| Wald $F$ | 0.945 | | 1.154 | |
| Probability | 0.334 | | 0.334 | |
| Wald $\chi^2$ | 0.945 | | 3.463 | |
| Probability | 0.331 | | 0.326 | |

In the same way, the null hypothesis from Eq. 2.8 could not be rejected as shown in Table 2.13.[45]

Table 2.13 Test for the Lack of Serial Correlation and Non-significant Zero Mean

| | ARCH(1,0) | | ARMA(6,1) | |
|---|---|---|---|---|
| LM 1 (4) | 0.947 | (5.200) | 2.293 | (2.293) |
| Probability 1(4) | 0.331 | (0.267) | 0.682 | (0.682) |
| Wald F | 1.282 | | 0.343 | |
| Probability | 0.262 | | 0.560 | |
| Wald $\chi^2$ | 1.282 | | 0.343 | |
| Probability | 0.258 | | 0.558 | |

[44] The SC of predictive accuracy was used to choose an integer $K$ in Eq. 2.7. Consequently, $K$=1 and $K$=3 was set for the ARCH(1,0) and ARMA(6,1) models, respectively.

[45] SC chooses $K$=1 for both models.

Nevertheless, the strong form efficiency test, presented in Eq. 9 rejects the notion of RE of inflation for both models. Table 2.14 presents the OLS estimates of the inflation regressed forecast errors ($\phi_{f,\ t}$) on the slightly modified monetary model given in Nikolić (2000a).[46] Efficient forecasting requires that the coefficients of all the information variables equal zero. A nonzero coefficient implies that forecasters could have improved their predictions by better exploiting the information set $I_{t-1}$ or its subset. Rationality also requires non-correlated error terms in these equations. Autocorrelated forecast error would imply that predictions could be improved by simply taking account of this phenomenon in generating predictions.

Table 2.14 OLS Estimates of the Strong Form Efficiency Test

| | ARCH(1,0) | | ARMA(6,1) | |
|---|---|---|---|---|
| Variable | Coefficient | *t*-Statistic | Coefficient | *t*-Statistic |
| $\pi_{t-1}$ | -0.144 | -3.248* | -0.104 | -2.952* |
| $m2x_{t-1}$ | 0.077 | 1.997 | 0.060 | 1.927 |
| $m2x_{t-2}$ | -0.058 | -1.537 | -0.093 | -2.739* |
| $m2x_{t-3}$ | 0.096 | 2.573* | 0.146 | 4.369* |
| $m2x_{t-4}$ | 0.054 | 1.432 | 0.038 | 1.124 |
| *DO*94 | 6.146 | 3.360* | 2.142 | 1.253 |
| *SBFEB*94 | -0.628 | -2.305* | -0.522 | -2.109* |
| | | | | |
| $R^2$ | 0.356 | | 0.390 | |
| $R^2$ adj. | 0.294 | | 0.334 | |
| S.E. | 1.790 | | 1.682 | |
| D.W. | 2.247 | | 2.272 | |
| | | | | |
| F | 5.722 | | 6.927 | |
| Prob. *F* | 0.000 | | 0.000 | |
| LM 1(7) | 0.849 | (16.920*) | 3.097 | (16.267*) |
| Prob. LM 1(7) | 0.357 | (0.018) | 0.078 | (0.023) |

[46] More specifically, contemporaneous values of $m2x$ are excluded from these regressions because it is assumed that agents do not have this information on their disposal. The same models are estimated including constant term but the results and conclusions are not significantly different. Similarly, autoregressions of higher order are also estimated i.e., 9 lags for inflation and 3 lags for $m2x$ as specified by the SC, but the results in respect of rationality are not qualitatively different.

Since values of $F$-statistics, in each of the models presented in Table 2.14, are not significant, we can reject hypothesis that the coefficients of all the information variables equal zero. Similarly, although the Breusch-Godfrey serial correlation LM test does not indicate the presence of the first order serial correlation for any of the models, it does so for the seventh order. Furthermore, rationality is undermined by the reasonably high coefficients of determinations. Hence, having established nonzero coefficients of the information variables and the presence of autocorrelation we can reject rationality hypothesis in its strong form.

### 2.8 Policy Implications and Direction for Further Research

Prevalence of persistent inflation[47] in Russian economy does not only signify accommodating character of Russian monetary policy, but also has strong implications for stabilization policy. It is the latter that seem to be neglected prior to summer of 1995 with adverse but somewhat predictable outcomes. Classic orthodox money based stabilization programs are not usually reputed for high credibility and transparency. Given the economic environment of persistent high inflation, this stabilization approach might have not been the most appropriate one to achieve rapid synchronized disinflation in Russia, particularly if commitment for fiscal adjustment was lacking. The sluggishness with which money-based programs reduce inflation, when they do at all, and their high costs in terms of output and unemployment, does not favour their implementation in countries where chronic inflation is persistent. In contrast, exchange rate based heterodox programs have ability to quickly break up both inertia and inflationary expectations and therefore bring inflation down to low levels.

Since it appears that the inflation in Russian economy is a result of both, inertia and expectations, an exchange rate-based heterodox stabilization might be an appropriate recommendation. Even though, a strong inflationary persistence would indicate a preference for this stabilization approach, this may not be without shortcomings. Such programs would need sizable foreign currency reserves, which Russia did not have at the beginning of stabilization attempts. In addition, heterodox elements, wage and price

[47] Since our models are reduced form models, we cannot however say that the inflation is persistent in a structural sense, or whether the appearance of persistence simply results from the economic policies used at the time, and the shocks hitting the Russian economy.

controls, may occasionally be superfluous and difficult to enforce. Furthermore, they can introduce substantial rigidity in relative prices and they may prove hard to phase out. Nevertheless, despite these shortcomings, it appears that this type of program, with an external financial assistance, would have performed better than orthodox money-based stabilization if introduced earlier. As the experience of July 1995 indicates, such a programme would have a clear dampening effect on inflationary expectations on one hand and would be likely to break up inflationary inertia on the other. Needless to say, a strong commitment to fiscal adjustment, as well as high likelihood of being followed, would need to be a *conditio sine qua non* for the success of such program, as indeed is the case for any stabilization program.

Even though both of our models seems to exhibit desirable statistical properties, the notable volatility of inflation in Russia in the given sample, indicates that this phenomenon may alternatively be duly modelled by Markov-switching model.[48] In contrast to conventional modelling, this approach makes explicit allowance for the possibility of structural change. In other words, Markov-switching model conjectures that two or more regimes could have prevailed over the course of history. That is, there is a regime, or a state, when inflationary expectations are low and one or more regimes when they are high. Series of shifts between the regimes (timing of breaks) occur in probabilistic fashion, thus endogenously rather than being imposed by the researcher. Such a model may be able to pick up endogenous shifts in the level of inflationary expectations in Russian economy and give superior results. In addition, Markov-switching model may be complemented by inclusion of other potential variables that explain inflation and are available for forecasts, i.e., unemployment, money supply, and output gap. Furthermore, it is more likely that such model may prove rational not only in the weak sense but also by the strong efficiency criteria described above.

## 2.9 Conclusion

In contrast to earlier claims, this chapter clearly demonstrates that lagged inflation in Russian economy was a very important determinant of the contemporaneous rate of inflation. In both, ADLM and ARMA models of inflation expectations, lagged inflation rates accounted for more than 90% of the variations in the contemporaneous inflation.

[48] See Hamilton (1989, 1990) and Ricketts and Rose (1995)

Economic agents could easily utilize both of these simple models to make consistent forecasts of a one-month ahead inflation rate. Unsurprisingly, even though they are unbiased and weakly efficient, these forecasts are not rational in the strong form of efficiency. In other words, in addition to previous inflation rates, economic agents could have used other available information at their disposal at the time to improve upon their forecasts. In addition, having identified a high degree of inflation persistency in Russian economy, this study implicitly suggests that, instead of the money-based stabilizations, exchange rate based stabilization with heterodox elements might have been more suitable for this transition economy. This stabilization approach would be more likely to both, dampen inflationary expectations and break inflationary inertia. The findings in this study indicate that the experience in terms of inflationary expectations of a transition economy may not be different from a market economy, but some of the institutional and historical legacies of the former socialist system should not be overlooked.

Finally, one has to be aware that a disadvantage of autoregressive models to predict sharp downturns and upturns in a series limits their value for forecasting. In particular, these kinds of models require that policies of the government have not changed sharply over the period under consideration. In other words, following the 'Lucas critique' one may claim that expectations obtained by mechanical extrapolation of the past value of a variable may fail to capture the change in the formation of expectations due to the policy rule change (Lucas, 1981). Furthermore, the measurement error, limited number of observations, and questionable reliability of Russian statistical apparatus could further undermine the relevance of the estimated inflationary expectations. However, in the absence of long run series of financial market indicators and sample surveys, these are economical forecasting alternatives, particularly suited for the short time forecasting.

# CHAPTER 3

## Money Growth Inflation Relationship in Postcommunist Russia[49]

### 3.1 Introduction

The relationship between the growth of different monetary aggregates and the rise in prices is one of the best-documented relationships in economic literature. In the simple analytical framework of Fisher's (1963) variant of the Quantity Equation, prices ($\dot{P}$) may increase as a result of a growth of money supply ($\dot{M}$), an increase of velocity of money ($\dot{V}$), or a decline of the total physical volume of transactions ($\dot{T}$), assuming in each case that other two factors remain unchanged.[50]

$$\dot{P} = \dot{M} + \dot{V} - \dot{T}. \tag{3.1}$$

In practice, changes in the other two factors may either add to or offset the initial disturbance, but empirical works often adopt the convention of the Naïve Quantity Theory (Locke, 1823), where $\dot{V}$ and $\dot{T}$ in Eq. (3.1) are treated as constants, with $\dot{P}$ varying in direct proportion to $\dot{M}$. Such a representation makes explicit the role of time, and thereby facilitates the study of the effect of monetary change on the temporal pattern of inflation.

Numerous empirical studies have demonstrated consistent patterns for money price relationships for various market economies. Monetarists argue that these studies have supported their claim that inflation can be produced only by a more rapid increase in the quantity of money than of output, and it is thus regarded as a purely monetary phenomenon (Friedman, 1989). While these propositions may be valid for market economies, they do not seem to be holding for the majority of transition economies. Except for Russia and Poland,

[49] I am indebted to the Editor of *Journal of Comparative Economics*, John Bonin, and two anonymous referees for the useful comments on the earlier versions of this paper. Responsibility for any remaining errors rests with the author.

[50] A dot over variables denotes the rate of growth.

no systematic pattern for the money price relationship was detected in transition economies, thus undermining the conventional monetarist view at least in the transitional context (Economic Commission for Europe, 1995).

Although it would be challenging to re-examine this relationship in all transition economies with the benefit of the longer data series now available, this chapter focuses attention solely on Russia. The main objective of this chapter is to scrutinize critically and rigorously the strength and the dynamics of the relationship between inflation and various monetary aggregates in post-communist Russia. In particular, we test firstly, whether this relationship is significant, and secondly, whether the lower inflationary environment that emerged in Russia in 1994, and especially in 1995, has caused the transmission of monetary impulses to future inflation to become both, slower and weaker. The evidence of the significant strength of this relationship and the insights into the dynamics may, under certain conditions, be an important aid for the creators of Russian monetary policy. [51]The reminder of this chapter is organized as follows. Section 2 discusses briefly Russian monetary policy to date and provides an overview of the literature on the topic. In section 3 the data and methodology, as well as the criteria for model selection, are delineated. The empirical results are reported and discussed in section 4, while section 5 analyzes the relationship between money and prices in both the early and the latter phases of transition. Section 6 concludes with the summary of the findings.

## 3.2 A Brief Overview of Russian Monetary Policy and the Literature

Unlike the majority of countries in Central and Eastern Europe that were able to regain relative macroeconomic stability soon after the beginning of their transition to market economy, Russia took a long time to bring inflation down to acceptable levels. Several, mainly half-hearted, stabilization programs, implemented between the autumn of 1991 and the spring of 1994, attempted to enforce tighter monetary conditions and tame inflation, only to be followed by periods of monetary expansion and renewed increases in prices. Even though the quest for macroeconomic stabilization has been characterized by

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[51] The conditions under which a significantly strong relationship between money supply and inflation may be a useful tool for policy making, apart from the issue of the temporal stability of model's parameters, is beyond the scope of this paper (see Nikolić, 2000b).

ups and downs rather than continuous improvement (Koen and Marrese, 1995), both money supply and inflation have had downward trends in Russia.

An examination of the balance sheet of the Central Bank of Russia (CBR) reveals that the main factors leading to growth of the money supply after the liberalization of prices in January 1992 were the CBR credits to the government, i.e., monetary financing of the budget deficit, to commercial banks, and to former Soviet republics. Since these mainly centralized credits were priced well below market clearing interest rate, the predominantly infinite demand for loans at negative real interest rates forced the CBR to follow International Monetary Fund's (IMF) suggestions and impose quantity constraints on the credit growth in the early 1993. These quantity constraints were accompanied with quantitative targeting of various aggregates of the money stock, a policy that was presented in the "Guidelines on the monetary policy of the CBR" in 1992 and continued for years after.

The setting of a positive real interest rate in early 1993, followed by a collapse of the Ruble zone and the steady increase in the political support for stabilization, shifted the main goal of monetary policy from short-run maintenance of output to the control of inflation. The ambitious March 1994 program, after some initial success in bringing inflation down to single digits in the summer of 1994, failed in its objectives as the monthly rate of inflation regained double digits in the autumn of 1994. Restrictive monetary policy reinforced by the unsustainably high interest rates led to the relaxation of monetary and fiscal policies in the summer of 1994. This, in turn, eventually led not only to the exchange rate collapse on Black Tuesday in October[52] of 1994, but also to the final realization that the days when the CBR could issue large credits without causing high inflation were over.

Despite CBR interventions to steady the value of the ruble, there was no explicit exchange rate target until 1995. In July of that year, an exchange rate band between 4,300 to 4,900 rubles per US-dollar was announced as an integral part of a well-prepared stabilization program. The signalling properties of an exchange rate target with respect to future inflation are high, particularly in a country where foreign currency, predominantly US dollars, is extensively used as an explicit unit of account. However, the success of the

[52] At the beginning of October 1994, the CBR lost control over the exchange rate and with reserves running low, was unable to prevent Black Tuesday on October 11 when the ruble (R) to dollar ($) exchange rate fell by 28%, jumping from R3,000 to almost R4,000 in one day. For the entire month of October, the exchange rate jumped from R2,361/$ to 2,994/$, which is equivalent to a month-to-month nominal depreciation of 26.8% (Russian Economic Trends (RET), 1994).

exchange rate stabilization program is by no means certain unless the fundamentals are brought under control. It is thus hardly surprising that the monetary stabilization succeeded for the first time, after failed attempts in the preceding years, when the government deficit was brought under control, even though only temporarily. Subsequent to earlier deficits of 18.9 percent in 1992, 7.7 in 1993, and 10.1 percent in 1994, the budget deficit was slashed to a respectable 4.9 percent in 1995 (Cheasty and Davis, 1996). This considerable reduction in the budget deficit, as well as the increased reliance on capital markets and foreign loans as sources of financing the subsequent deficits, are the main reasons for success of 1995 stabilization program.

However, macroeconomic stability is always fragile in transforming economies like the Russian Federation in which the fiscal deficit has averaged close to 8 percent per annum up to 1998. After a substantial decrease in the accumulated deficits in the early years of transition, the debt to GDP ratio climbed to about 50 percent in 1996. The rise of accumulated deficits pushed up debt service costs for the future, and so increased the size of future deficits. As markets viewed the government's finances, and thus the exchange rate target, as unsustainable, this perception led to a higher currency risk premium, which resulted in upward pressure on interest rates.[53] The higher interest rates, in turn, led to an increase in the future debt service costs and so thus increased the future expected budget deficit. The spiral was further exacerbated by the adverse effects of a higher interest rate on growth, of dwindling foreign exchange reserves, and of the compounded perception of less than credible government policies, all of which eventually led the country into a variant of the debt-trap.

The dire position of government finances and the economy as a whole was undermined further by the external and other internal factors. The most important of the external factors, in the aftermath of the 1997 Asian crises, was the fall in confidence on the part of the international capital investors to invest in countries like Russia, which was, and still is, plagued by macroeconomic and structural weaknesses, particularly over-dependence on short term capital inflows (RET, 1998). The second adverse external factor was the fall of oil and other commodity prices. Among the domestic factors the most important were the excessively large budget deficit and the unsustainable build up of ruble-denominated

[53] The currency risk premium is defined as the difference between the interest rate for the same maturity instrument of ruble-denominated domestic debt, taking into account the depreciation expected under the current exchange rate policy, and dollar-denominated government debt.

debt. These adverse domestic factors originated from problems associated with poor tax collection, non-productive government expenditures, a small and weak domestic capital market, a weak and inefficient banking system, poor corporate governance, and the continued accumulation of payment arrears (RET, 1998). The failure of the policymakers to address these issues in the relatively favourable investment climate of 1997 led Russia, in August 1998, into the worst financial crises of its transition period and contributed to the global financial turbulence. The ruble was effectively devalued and left floating while the government defaulted on its own maturing short-term securities (Gosudarstvennye Kratkosrochnye Obligatsii).[54] Although inflation averaged relatively low levels of well below 2 percent per month in the 3 years after the 1995 stabilization, prices jumped by over 38 percent in September 1998 and by almost 12 percent in December of the same year. The earlier downward trend in the rise of prices continued in subsequent months, as inflation averaged just over 4 percent in the first 5 months of 1999.

Having briefly described the Russian monetary policy during transition, we turn to issues related to the transmission of monetary impulses to prices. Russia, along with Poland, may be viewed as a special case among transition economies, because their money supply has had a systematic impact on inflation rate.

In earlier studies (Easterly and Viera da Cunha, 1993; Fisher, 1994; Koen and Marrese, 1995; Hoggarth, 1996; Allen *et al.*, 1996; Korhonen, 1996; Korhonen and Pesonen, 1998; and Korhonen, 1998), researches claimed that inflation in Russia, since price liberalization at the beginning of 1992, clearly has monetary roots.[55] In all of these studies, the past growth of ruble broad money ($M2$) is claimed to have the strongest influence on inflation rate among various monetary aggregates. Working with a limited set of data, these authors found that the acceleration of inflation, in a few years after price liberalization in Russia, corresponds closely to the acceleration in the growth of $M2$ with a lag of up to four months. However, these findings differ with respect to the strength of the influence of various lags of $M2$ on inflation and the length of the period covered by analysis.[56] The atypical short length of the time lag between money supply and inflation in

[54] In 1998, the official exchange rate went from R5,96/$ to R20,65/$, a depreciation of 246 per cent. From August 1998 to end-March 1999, the ruble has depreciated 287 per cent, from R6,24/$ to R24,16/$.

[55] However, this view is not shared unanimously among Russian economists. Koen and Marrese (1995) pointed out Petrakov, who maintained that inflation in Russia is fundamentally caused by the structural deformities of the economy.

[56] For a comprehensive survey, see Korhonen and Pesonen (1998).

Russia,[57] according to Hoggarth (1996), is a consequence of the tenet according to which the length of the time lag between changes in money growth and inflation is in direct proportion to the stage of transition process of a country. Similarly, Buch (1998) claimed that the speed of transmission of monetary impulses into prices is inversely related to the sophistication of country's financial system, and this process is comparatively fast in Russia because its financial system is not very sophisticated.

Hoggarth (1996) and Allen *et al.* (1996) suggested that a temporary fall in the inflation rate not only may reduce the extent to which money growth affects future inflation but also, by establishing a lower inflationary environment, lengthen permanently the time lag of monetary policy.[58] Consequently, Hoggarth (1996) suggested that the lag from *M*2 growth to inflation in Russia appeared to have increased from three to four months in the 1992 to 1993 period to six months in the lower inflationary environment of 1994. These findings are also supported by Korhonen and Pesonen (1998) who concluded that the lag length between money growth and prices in Russia, for the period between January 1992 and October 1997, has shifted gradually from lags of one to four months to longer lag lengths. Similarly, Alan *et al.* (1996) concluded that, in the lower inflationary environment in both Russia and Poland from 1993 to 1994, money velocity became more uncertain, with the implication that a change in the broad money growth had a weaker and a more prolonged influence on future inflation. The results from these two transition economies are implied (Alan *et al.*, 1996) to have wider implication for some major economies where the present very low rates of inflation could, in principle, increase the time lag of monetary policy.

### 3.3 Data and Methodological Overview

The method and the objectives of this analysis differ from previous studies. First, we employ the longest time series available to date, covering the entire period since the

[57] In Western economies, the lag from monetary policy changes to inflation is much longer. For example, Carlson (1980) reported that the change in money supply in the US economy is felt over a period of 20 quarters with a mean lag of about 11 quarters, for the period from 1955 to 1969. Similarly, Hoggarth (1996) wrote that, in the UK, the lag is estimated to be between 2 and 3 years and reiterated the claim that monetary policy effects are broadly similar across G7 countries.

[58] As Hoggarth (1996) noted, the short run Philips Curve may be flatter at low rates of inflation than at high rates.

liberalization of prices in January 1992 until the Russian financial crisis of August 1998. Second, in addition to using data for *M*2, which is claimed to have had the strongest link with inflation in the previous studies, we also analyze the narrower and more easily controlled monetary aggregates, ruble cash (*M*0) and the monetary base (*MB*), as well as extended broad money (*M2X*). Third, instead of arbitrarily choosing the lag length of money supply aggregates or applying the rule of thumb method, we employ statistical criteria to select the optimum lag length. Fourth, various statistical tests and diagnostic statistics are applied and presented to test the performance and robustness of the given model. Finally, measures of summary statistics are employed in order to quantify, albeit tentatively, the impact of changes in growth of money on the temporal pattern of the response of prices.

As in most previous studies, this study is conducted using data published by the RET.[59] These data consist of monthly observations of the Consumer Price Index (*CPI*) and the monetary aggregates, i.e., ruble currency outside the banks (*M*0), base money (*MB*), which is defined as *M*0 plus the minimum reserve requirements of the CBR on commercial banks, ruble broad money (*M*2), which is defined as *M*0 plus ruble deposits in the banking system, and extended broad money (*M2X*), which is defined as *M*2 plus foreign exchange deposits with domestic banks.

As an empirical work on time series requires, all variables were examined for stationarity and cointegration. Not surprisingly, no variable in its original form was found to be stationary, nor were any of the original times series of monetary aggregates cointegrated with the CPI. In order to obtain stationary time series, we employed the growth rates of each individual variable, which is approximately equivalent to combining differencing transformation, or operator as it is often termed, with power transformation.[60]

The growth rates of each time series (*CPI*, *M*0, *MB*, *M*2, and *M2X*), denoted as $\pi$, *m*0, *mb*, *m*2 and *m*2*x* respectively, were found not to exhibit a unit root; i.e., all series were

[59] The first observation for all of the series, except the *MB* series, is February 1992. For the *MB* series, the first available observation in the RET is May 1992. All of the estimations are done in EViews (v. 3.0), except the Run test, which is done in Minitab (v. 9.2).

[60] Thus, in this combination, rates of growth are equivalent to differences of logarithms, since

$$\Delta \log (x_t) = \log (x_t) - \log (x_{t-1}) = \log (x_t / x_{t-1}) \cong (x_t / x_{t-1}) - 1 = (x_t - x_{t-1}) / x_{t-1}$$

as long as the ratio $x_t / x_{t-1}$ is reasonably small.

found to be stationary at the conventional 5 percent level of significance.[61].The results of the standard unit root tests, such as augmented Dickey-Fuller (ADF) and Phillips-Perron (PP), are presented in Table 3.1.

Table 3.1 Unit Root Tests: 1992:02-1998:07

| | $m0$ | $mb$ | $m2$ | $m2x$ | $\pi$ |
|---|---|---|---|---|---|
| ADF | -2.73* | -5.19* | -3.93* | -4.02* | -4.07** |
| Specification[a] | 0, 0(11) | 0, 0(11) | 0, 0(11) | 0, 0(11) | C, T(1)[c] |
| LM1, (LM4)[b] | 0.00, (7.55) | 1.03, (7.47) | 1.02, (3.04) | 1.26, (3.24) | 3.54, (9.01) |
| PP | -8.47* | -6.67* | -6.60* | -6.63* | -4.46* |
| Specification[a] | C, T(3) | C, T(3) | C, T(3) | C, T(3) | C, T(3) |

*Note*: * (**) indicates 1 (5) percent level of significance.

[a]Indicates whether a linear trend (T) and/or a constant term (C) has been introduced and the maximum lag length of the dependent variable (in parenthesis).

[b]Chi-square – values of an LM test on 1st (4th) order autocorrelation. Critical values at the 5 percent level of confidence are 3.84 (9.49). [c]Alternatively, ADF is 2,45 for 0,0 (13). Also significant at 5 percent level, LM(1)=0.67, LM(4)=1.21

In order to examine seasonality patterns in the data, all variables were regressed against a constant, a trend, and the seasonal dummies, $D_k$'s. A seasonal dummy, $D_k$, was set to equal 1 for the month in which seasonal variation was observed and 0 otherwise, and $k$=1...11, denotes the month in which the value for a dummy is set equal to 1 e.g., $D_1$=January, $D_2$=February, ... $D_{11}$=November. While inflation series do not contain any seasonal component, all of the money supply measures, except the *M2X* series, do, as reported in Table 3.2. In addition, a dummy variable *DO94* is included to account for the exogenously induced inflation that occurred in 1994 as result of the exchange rate crises of

[61] Inflation rate time series might have had a structural break at the beginning of 1994 when the inflation rate decreased markedly without a significant change in the trend (slope) over the period. Applying the modified unit root test (Perron, 1989), the previous assumption concerning a structural break is confirmed and the unit root hypothesis rejected. Following Perron's proposed unit root test, we included a dummy variable to account for a potential structural break. Hence, the following regression was estimated:

$$\Delta\pi = \underset{(4.59)}{15.32} - \underset{(3.71)}{0.15}trend - \underset{(4.23)}{4.52}D_u - \underset{(4.88)}{0.61}\,\pi_{-1} + \sum_{i=1}^{9}\chi_i\Delta\pi_{-1}$$

where $D_u$ is a dummy variable so that $D_u$=1 after January 1994 and 0 otherwise, while $t$-ratios are in the brackets. The values of the test statistics for the Dummy variable (4.23) and for the one period lagged inflation (4.88) imply a structural break and the rejection of a unit root, respectively.

October 1994 (Black Tuesday). The dummy variable takes a value of 1 for October 1994 and zero otherwise.[62]

Following earlier studies, (Easterly and Viera da Cunha, 1993; Koen and Marrese, 1995; Hoggarth, 1996; Allen *et al.*, 1996; Korhonen and Pesonen, 1998) changes in prices ($\pi$) are modelled as a function of each of the aggregates of money supply ($m$). All variables are in growth form and the following model is estimated:

$$\pi_t = c_0 + \sum_{j=0}^{N} \beta_j m_{t-j} + \sum_{k=1}^{S} \gamma_k D_{kt} + \phi DO94_t + e_t \tag{3.2}$$

where $c_0$ is a constant; the $\beta$'s are parameters of money supply to be estimated; subscripts $j$ and $t$ denote the lag length and the current time period, respectively; $N$ is the maximum number of lags; $D_{kt}$'s and $\gamma_k$'s are the seasonal dummies and their respective coefficients; $S$ is the number of seasons; $DO94$ and $\phi$ are the October 1994 dummy and its respective coefficient; and $e$ is the stochastic error term that follows the classical assumptions, namely, it has zero mean, constant variance, and is not autocorrelated.

Generally, this model is a version of a distributed lag (DL) model associated with the monetarist tradition and could be viewed as a restricted form of the Saint Louis equation.[63] Like other similar monetary models, it is not intended to explain each and every wiggle in the rate of change of prices, but rather it is a short hand description of the fundamental inflation process.[64] The equation implies that disequilibrium in the money market, for a given stock, is eliminated only by changes in the general level of prices. Unlike in structural models, exclusion of nonmonetary factors in Eq. (3.2) reflects the view that the potential exogenous shift variables have only temporary or short-run impacts on the rate of inflation.[65]

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[62] While there have been many financial and other crises in Russia during transition, the magnitude of the Black Tuesday crises, if not taken into account, renders a simple distributed lag (DL) model of money price relationship shown below to be unstable. In addition to the structural break that seems to occur in October 1994, the failure to take account of this exogenous shock causes the true partial coefficients simultaneously to equal zero ($F$-test). A similar exogenous shock, but with a greater magnitude, seems to have taken place in August 1998. It would be necessary to take this into account in a similar manner if the period after July 1998 were modelled.

[63] For a proof of this statement, see Andersen and Karnosky (1974).

[64] An alternative approach for future research aimed at establishing a causal relationship could apply cointegration analysis to this restrictive functional form.

[65] The arguments about the superiority of structural or monetarist models are beyond the scope of this paper.

In empirical work, it is common practice to adopt some a priori restrictions on the $\beta$ coefficients in models like the one depicted by Eq. (3.2). This is usually done by assuming that the $\beta$'s follow some systematic pattern. Thus, researchers often assume that the $\beta$ coefficients either decline geometrically (the Koyck DL model),[66] or follow a cyclical pattern (the Almon or Polynomial DL model with or without restrictions).[67] Since these models impose some artificial patterns on the distribution of the $\beta$ coefficients over time that are not likely to coincide with their true distribution, their usefulness for our purpose is limited. Therefore, as our goal is to establish the true distribution of the $\beta$ coefficients, which reflects the relative importance or weights of each lagged value ($j$) of $m$, we proceed without imposing any restrictions on the distribution of $\beta$'s.[68]

Inclusion of a single, one term, lagged dependent variable ($\pi_{t-1}$) as an explanatory variable in Eq. (3.2) yields an autoregressive dynamic model suggested in the previous literature (Hoggarth, 1996; Allen *et al.*, 1996; Korhonen and Pesonen, 1998). This model is specified by Eq. (3.3):

$$\pi_t = c_0 + \alpha_1\pi_{t-1} + \sum_{j=0}^{N} \beta_j m_{t-j} + \sum_{k=1}^{S} \gamma_k D_{kt} + \phi DO94_t + e_t \qquad (3.3)$$

This procedure could be justified by observing that $\pi_{t-1}$ contributes a great deal to the contemporary inflation rate, and thus the model captures the significant inflationary inertia prevalent in the Russian economy.

Since values of the $\beta$ coefficients in Eqs. (3.2) and (3.3) are likely to be sensitive to the choice of the lag length, careful attention must be given to the manner in which lag length is set. In the majority of the empirical studies on this subject known to us, either some ad hoc approach or a rule of thumb method was applied to specify the lag length. In contrast, we employ the Schwarz (Bayesian) Criteria (SC) and the Akaike Information

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[66] Since the Koyck DL model, although neat, is obtained by a purely algebraic process, and thus devoid of any theoretical underpinning, it is often rationalized as an adaptive expectation model or a partial adjustment model or a combination of both.

[67] For application of Almon lag technique, see Almon (1971), and for problems in the application of this technique see Schmidt and Waud (1973).

[68] We recognize that, in models like one depicted in Eq. (3.2), multicollinearity is likely to appear. In other words, since successive values (lags) tend to be highly correlated, the standard errors tend to be large and, therefore, the estimation of coefficients is likely to be less than fully efficient. Nevertheless, multicollinearity violates no regression assumptions. Unbiased, consistent estimates will occur. The only effect of multicollinearity is to make it hard to get coefficients estimates with small standard error. Moreover, multicollinearity may not pose a serious problem in the case when $R^2$ is high and the regression coefficients are individually significant as revealed by high $t$ values.

Criteria (AIC) to determine the most appropriate lag structure for the model.[69] Implementing the SC and AIC tests for the selection of the optimal lag length, $l^*$, in Eqs. (3.2) and (3.3), with the maximum number of lags, $N$, set at 15 , yielded the results presented in Table 3.2.

Table 3.2 Seasonal Dummies and the Optimum Lag Length ($l^*$) Selection Using SC and AIC

| OLS method | Independ. Variab. | Seasonal Dummies | SC ($l^*$) | AIC ($l^*$) |
|---|---|---|---|---|
| Eq. 3.3 | $m0$ | $D_1, D_4, D_6$ | 6.2607 (8) | 5.811 (8) |
| | $mb$ | $D_1, D_4, D_6, D_7$ | 5.8492 (4) | 5.4674 (5) |
| | $m2$ | $D_1, D_6$ | 5.9104 (8) | 5.4928 (8) |
| | $m2x$ | | 5.6556 (13) | 5.1203 (13) |
| Eq. 3.4 | $m0$ | $D_1, D_4, D_6$ | 4.6918 (9) | 4.0411 (15) |
| | $mb$ | $D_1, D_4, D_6, D_7$ | 4.5849 (5) | 4.1587 (6) |
| | $m2$ | $D_1, D_6$ | 4.4063 (9) | 3.9206 (9) |
| | $m2x$ | | 4.5120 (9) | 4.0382 (12) |

*Note*: The dependent variable is the rate of inflation ($\pi_t$) in all estimates and the $l^*$'s are given in parenthesis.

### 3.4 The Results

Although not presented here, estimations of the DL model expressed in Eq. (3.2) using the OLS method produced a high $R^2$ of over 80% for each of the monetary aggregates. However, the $R^2$ was greater than the Durbin Watson (DW) statistic in all cases, pointing to the presence of serial correlation in the data. Following Maddala (1992), we re-estimated Eq. (3.2) in first differences using the OLS method, and dropping the intercept term for all monetary aggregates. Subsequent to a new optimal lag length selection by re-application of the SC, the estimates of the DL model in first differences are presented in Table 3.3.

[69] The test statistics are given by SC=$-2L/n+k\log n/n$ and AIC=$-2L/n+2k/n$ respectively where $k$ is the number of estimated parameters, $n$ is the number of observations, and $L$ is the value of the log likelihood function using the $k$ estimated parameters. In order to select the most appropriate model, we choose the values that minimize the SC and AIC. Among various statistical criteria, SC has superior large sample properties and therefore it is favored when it suggests a different lag selection from the AIC.

Table 3.3 OLS Estimates of the DL Model of Inflation in First Differences

| | *m*0 | | *mb* | | *m*2 | | *m*2*x* | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. |
| $\beta$ | 0.096 | 1.93 | -0.045 | -0.71 | 0.046 | 0.92 | -0.024 | -0.60 |
| $\beta_1$ | 0.159 | 3.08* | 0.089 | 1.40 | 0.243 | 4.75* | 0.048 | 0.99 |
| $\beta_2$ | 0.118 | 2.39* | 0.068 | 1.08 | 0.144 | 2.53* | 0.018 | 0.35 |
| $\beta_3$ | 0.079 | 1.76 | 0.043 | 0.67 | 0.161 | 2.76* | 0.114 | 2.28* |
| $\beta_4$ | 0.121 | 2.67* | 0.077 | 1.48 | 0.211 | 4.32* | 0.161 | 3.43* |
| $\beta_5$ | 0.167 | 3.31* | | | 0.203 | 3.80* | 0.118 | 2.54* |
| $\beta_6$ | 0.177 | 3.57* | | | 0.193 | 3.92* | 0.028 | 0.60 |
| $\beta_7$ | 0.108 | 2.68* | | | 0.063 | 1.41 | 0.033 | 0.82 |
| $\beta_8$ | 0.008 | 0.26 | | | 0.006 | 0.16 | 0.006 | 0.16 |
| $\phi$ | 7.796 | 3.84* | 6.741 | 3.22* | 7.188 | 4.32* | 6.358 | 3.47* |
| $\gamma_1$ | 4.027 | 3.32* | 1.021 | 0.99 | 1.976 | 2.32* | | |
| $\gamma_4$ | -1.552 | -1.43 | -0.349 | -0.30 | | | | |
| $\gamma_6$ | -0.264 | -0.27 | -0.521 | -0.52 | -0.461 | -0.61 | | |
| $\gamma_7$ | | | -0.414 | -0.46 | | | | |

| Model Performance | | | | |
|---|---|---|---|---|
| $R^2$ | 0.41 | 0.28 | 0.55 | 0.40 |
| Adj. $R^2$ | 0.28 | 0.17 | 0.47 | 0.31 |
| S.E. | 1.86 | 2.00 | 1.60 | 1.82 |
| *F*-statistic | 3.19* | 2.56* | 6.44* | 4.38* |
| Log likelihood | -133.60 | -140.21 | -123.72 | -133.90 |
| D.W. | 1.66 | 1.75 | 1.61 | 2.04 |
| LM 1 (4) | 0.36 (1.62) | 0.00 (4.643) | 1.97 (6.45) | 0.00 (1.028) |
| ARCH LM (lag) | 9.256 (1)* | 6.83 (1)* | 7.599 (1)* | 12.46 (1)* |
| Skewness | -0.324* | -0.125 | -0.214 | -1.030* |
| Kurtosis | 3.392 | 4.110* | 3.054 | 6.959* |
| Jarque-Bera | 1.651 | 3.724 | 0.534 | 57.251* |
| SC ($l$*) | 4.670 (8) | 4.678 (4) | 4.322 (8) | 4.495 (8) |

| Summary statistics | | | | |
|---|---|---|---|---|
| Long run mult. | 1.03 | 0.23 | 1.27 | 0.50 |
| Mean Lag | 3.71 | 2.85 | 3.56 | 4.20 |

*Note*: An asterisk indicates significance at 5 per cent or better level. The asymptotic standard errors of the skewness and kurtosis coefficients are $\sqrt{(6/T)}$ and $\sqrt{(24/T)}$, respectively, where $T$ is the sample size. An asterisk associated with the coefficients of skewness and/or kurtosis indicates significance and implies that the coefficient exceeds twice its standard error. The Jarque-Bera (JB) normality statistic is distributed as Chi-square with two degrees of freedom.

The performance and the diagnostic statistics of the DL model presented in Table 3.3, for each monetary aggregate, suggest that the OLS method may not give satisfactory results. The statistics reveal that our assumptions about the error term, $e$, may not be satisfied. More specifically, $e$ is assumed to have zero mean, constant variance, and not to be autocorrelated. However, visual inspection of the forecast errors revealed their large variability over time. This suggests that the variance of the forecast error is not constant but varies from period to period. In other words, there seems to exist a particular kind of heteroscedasticity in which the variance of the regression error depends on the volatility of the errors in the recent past. Indeed, the null hypothesis of no correlation in the variance of the OLS residuals, formally tested by the Lagrange Multiplier (LM) test for autoregressive conditional heteroscedasticity (ARCH), was rejected for all monetary aggregates at the conventional level of significance. Additionally, we calculated the coefficient of skewness (a test of symmetry) and kurtosis (a test for fat tails) for the estimated residuals and performed a Jarque-Bera (JB) normality test.[70]

Since, in the presence of heteroscedasticity, biased and inconsistent estimation of the variances of the OLS parameters estimates render statistical inferences invalid, Engle (1982) suggested that the use of an ARCH model would lead to increased efficiency. In such a model, Eq. (3.2) needs to be complemented by an additional equation, that relates the variance ($\sigma^2_t$) of the error term ($e_t$) to the amount of volatility observed in the recent period. This model is written in the following form (ARCH($p$) model):[71]

$$\sigma^2_t = \delta_0 + \delta_1 e^2_{t-1} + \delta_2 e^2_{t-2} + \dots \delta_p e^2_{t-p}. \tag{3.4}$$

The presence of ARCH effects could be, and usually is, corrected by the maximum likelihood estimation (MLE). Assuming normality and ARCH errors, the MLE estimates

[70] A zero value of the skewness coefficient and a large value (over 3) of the kurtosis coefficient would suggest the existence of ARCH effect. So similarly, a large value for the JB test would indicate a rejection of the null hypothesis of normality and would also be consistent with the existence of ARCH effects.

[71] Eq. (3.4) can be further generalized into a general autoregressive conditional heteroscedasticity model, GARCH($p$,$q$), in which the conditional variance of $e$ at time $t$ is dependent not only on past squared disturbances but also on past conditional variances:

$$\sigma^2_t = \delta_0 + \delta_1 e^2_{t-1} + \dots + \delta_p e^2_{t-p} + \lambda_1 \sigma^2_{t-1} + \dots + \lambda_q \sigma^2_{t-q}.$$

By the same token, we can introduce $\sigma^2_t$ (or, alternatively, the standard deviation $\sigma_t$) on the right hand side of Eq. (3.3), in order to test whether inflation is dependent on the $\sigma^2_t$ or $\sigma_t$ of the forecast error as well as on changes in money supply. This is referred to as an ARCH-M (ARCH-in-mean) model. For a survey and an overview of the application of ARCH and GARCH models, see Bollerslev *et al.* (1992).

are determined through an iterative search, which amounts to maximizing the log likelihood function ($l$) of the following form:

$$l_t = -\,0.5 \log \sigma^2_t - 0.5\, e^2_t / \sigma^2_t. \tag{3.5}$$

An alternative ARCH specification could be obtained by minimizing the SC of predictive accuracy. In our case, both criteria provide similar or equivalent information about the exact linear specification of the conditional variance function for all monetary aggregates, except for the monetary base.[72] However, none of the criteria does seem to give an ARCH/GARCH specification that makes the growth of monetary base a good proxy of inflation. Therefore, the specification of the equation involving *mb*, obtained by the SC, which is more parsimonious, is presented in Table 3.4 along with the other exact orders of the ARCH/GARCH models for the rest of monetary aggregates.[73]

Table 3.4 Maximum Likelihood Estimates of the DL Model of Inflation

| | *m*0 | | *mb* | | *m*2 | | *m*2*x* | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. |
| $\beta$ | 0.029 | 1.12 | -0.017 | -0.71 | -0.037 | -2.06* | 0.036 | 1.33 |
| $\beta_1$ | 0.028 | 1.22 | 0.007 | 0.23 | 0.113 | 3.68* | 0.072 | 1.54 |
| $\beta_2$ | 0.006 | 0.29 | -0.030 | -0.94 | 0.036 | 1.44 | 0.058 | 1.43 |
| $\beta_3$ | -0.022 | -1.14 | -0.009 | -0.32 | 0.084 | 3.38* | 0.101 | 2.85* |
| $\beta_4$ | -0.003 | -0.12 | 0.016 | 0.76 | 0.150 | 10.35* | 0.137 | 8.35* |
| $\beta_5$ | 0.018 | 1.09 | | | 0.120 | 5.46* | 0.115 | 8.37* |
| $\beta_6$ | 0.018 | 1.23 | | | 0.076 | 3.80* | 0.040 | 2.88* |
| $\beta_7$ | 0.065 | 3.64* | | | 0.023 | 1.28 | 0.048 | 2.34* |
| $\beta_8$ | 0.014 | 1.81 | | | 0.000 | -0.03 | 0.029 | 0.96 |

[72] Iterative estimation of $l$ indicates that the best specification for an ARCH/GARCH model for the monetary base is GARCH(2,1), while SC favors GARCH(1,1). The tests for determining the exact order of the ARCH and GARCH models are not reported but are available from the author upon request.

[73] We have looked at ARCH(1), ARCH(2), and ARCH(3) models and, as it has become a convention, at GARCH(1,1), GARCH(1,2), and GARCH(2,1) models. A data set that requires a model of order greater than these presented is very rare (see Bera and Higgins, 1993).

Table 3.4 *continued*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| $\phi$ | 7.083 | 0.50 | 4.925 | 1.32 | 10.493 | 8.18* | 6.670 | 0.37 |
| $\gamma_1$ | 0.676 | 1.17 | 0.533 | 0.58 | 0.968 | 2.36* | | |
| $\gamma_4$ | -0.505 | -1.79 | 0.023 | 0.04 | | | | |
| $\gamma_6$ | -0.035 | -0.14 | -0.321 | -1.01 | -0.302 | -1.25 | | |
| $\gamma_7$ | | | 0.003 | 0.01 | | | | |
| $\delta_0$ | -0.010 | -0.78 | -0.020 | -1.44 | 0.173 | 1.22 | -0.008 | -0.79 |
| $\delta_1$ | -0.025 | -0.20 | 0.223 | 1.56 | 1.078 | 2.53* | 1.008 | 8.18* |
| $\delta_2$ | 0.582 | 2.29* | | | 1.014 | 3.62* | -0.892 | -8.73* |
| $\lambda_1$ | 0.538 | 4.22* | 0.780 | 9.01* | -0.621 | -3.67* | 0.906 | 12.97* |
| **Model Performance** | | | | | | | | |
| $R^2$ | 0.167 | | 0.182 | | 0.450 | | 0.334 | |
| Adj. $R^2$ | -0.089 | | 0.007 | | 0.295 | | 0.177 | |
| S.E. | 2.288 | | 2.185 | | 1.841 | | 1.989 | |
| *F*-statistic | 0.653 | | 1.041 | | 2.893* | | 2.12* | |
| Log likelihood | -95.142 | | -108.855 | | -99.785 | | -104.290 | |
| Run test | 0.058* | | 0.534* | | 0.493* | | 0.163* | |
| Skewness | -0.202 | | -0.234 | | 0.353* | | -0.017 | |
| Kurtosis | 3.119 | | 3.235 | | 2.183 | | 3.304 | |
| Jarque-Bera | 0.512 | | 0.787 | | 3.352 | | 0.270 | |
| SC ($l$*) | 3.801 (8) | | 3.953 (4) | | 3.874 (8) | | 3.882 (8) | |
| **Summary statistics** | | | | | | | | |
| Long run mult. | 0.15 | | -0.03 | | 0.57 | | 0.64 | |
| Mean Lag | 4.76 | | 0.47 | | 3.99 | | 3.81 | |

Q-statistics for Standardized Residuals

| lag | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *m*0 | 3.02 | 3.02 | 3.50 | 5.38 | 6.33 | 7.16 | 7.18 | 7.35 | 7.43 | 10.24 | 11.08 | 11.08 | 11.08 | 12.05 | 12.10 | 13.06 | 16.45 | 18.17 |
| *mb* | 2.08 | 3.97 | 9.46* | 16.4* | 16.5* | 16.78* | 17.94* | 18.05* | 18.24* | 22.76* | 22.76* | 25.30* | 25.41* | 26.44* | 26.45* | 26.47* | 27.13 | 27.93 |
| *m*2 | 0.14 | 0.23 | 0.42 | 1.15 | 2.41 | 2.42 | 2.83 | 2.83 | 3.89 | 4.69 | 7.83 | 7.85 | 8.68 | 9.94 | 10.41 | 12.73 | 14.02 | 15.28 |
| *m2x* | 0.12 | 0.15 | 0.15 | 1.12 | 2.13 | 6.56 | 7.36 | 8.92 | 8.94 | 9.57 | 9.67 | 13.95 | 13.96 | 18.45 | 18.76 | 18.82 | 20.05 | 21.79 |

Q-statistics for Squared Residuals

| lag | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *m*0 | 0.00 | 0.43 | 0.63 | 0.70 | 1.61 | 2.16 | 2.55 | 4.75 | 4.79 | 4.84 | 5.14 | 6.04 | 6.18 | 6.23 | 6.43 | 6.46 | 7.02 | 7.53 |
| *mb* | 0.01 | 0.46 | 0.99 | 1.01 | 1.81 | 1.94 | 1.96 | 2.24 | 2.60 | 2.73 | 3.00 | 4.41 | 4.41 | 4.63 | 4.81 | 4.89 | 4.91 | 6.80 |
| *m*2 | 0.51 | 2.96 | 3.06 | 3.06 | 7.75 | 10.48 | 11.11 | 11.11 | 11.20 | 11.25 | 11.35 | 11.37 | 11.37 | 11.55 | 12.50 | 12.61 | 14.56 | 15.38 |
| *m2x* | 0.10 | 0.25 | 0.50 | 4.05 | 6.22 | 6.26 | 6.36 | 6.43 | 6.49 | 6.92 | 7.74 | 7.76 | 7.97 | 9.78 | 9.80 | 10.95 | 11.00 | 11.07 |

*Note*: * significant at 5% or better level.

The performance and the diagnostic statistics of the DL model of inflation corrected for ARCH effects presented in Table 3.4 reveal that, in addition to monetary base, the growth of ruble cash money does not seem to be a good proxy for inflation. Even though the coefficient of seven months lagged ruble cash seems to be highly significant individually, the overall test of significance of the regression line, i.e., the *F*-statistic, indicates that the coefficients are simultaneously not different from zero. In addition, the Q-statistics for standardized residuals, in the equation containing *mb*, is significant implying the presence of autocorrelation.

In contrast, the diagnostic statistics of both measures of broad money supply, *m*2 and *m*2*x*, suggest that they both explain variations in inflation rate (Table 3.4). The Q-statistics of the standardized and square residuals as well as the run test statistics do not justify rejection of the null hypothesis of no significant correlations. Even though the coefficient of skewness associated with the equation containing *m*2 marginally exceeds twice its standard error, neither the ARCH LM test (not reported) nor the Q-statistics of squared residuals reveal the presence of the ARCH effects. With respect to the variations in the current inflation rate, the growth of lagged *m*2 explains just under a half of them and somewhat more than does *m*2*x*. Most of the coefficients and all of the ARCH/GARCH terms are statistically significant for both aggregates. However, the significantly negative coefficient of the current *m*2 seems to run counter to economic theory. Nevertheless, the general requirement that all $\beta$s are positive, although common, is somewhat too stringent. It may be possible that a number of short run shocks, such as administrative price adjustments of oil and gas, exchange rate swings, swings in the regime of monetary policy, or discrete income policy decisions, may render the lag structure unstable in a relatively short sample. Perhaps more importantly and more likely, inflation may overreact initially to a change in money supply and compensating adjustments may be needed subsequently, as it appears to be the case in our sample.

As was the case for the DL model, the OLS method does not seem appropriate for the ADL model expressed in Eq. (3.3). The ARCH LM test as well as the Q-statistics of the squared residuals (not reported), indicate the presence of ARCH effects for all monetary aggregates (Table 3.5).

Table 3.5 OLS Estimates of the ADL Model of Inflation

| | $m0$ | | $mb$ | | $m2$ | | $m2x^a$ | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | $t$-Stat. | Coeff. | $t$-Stat. | Coeff. | $t$-Stat. | Coeff. | $t$-Stat. |
| $c$ | -0.558 | -1.37 | -0.631 | -1.62 | -0.545 | -1.47 | -0.401 | -2.03* |
| $\alpha$ | 0.869 | 15.23* | 0.779 | 12.50* | 0.876 | 14.92* | 0.818 | 8.80* |
| $\beta$ | 0.089 | 1.69 | 0.030 | 0.44 | 0.038 | 0.72 | -0.052 | -0.75 |
| $\beta_1$ | 0.057 | 1.69 | 0.095 | 1.88 | 0.178 | 3.68* | 0.055 | 1.14 |
| $\beta_2$ | -0.036 | -0.95 | -0.019 | -0.37 | -0.072 | -1.60 | -0.020 | -0.48 |
| $\beta_3$ | -0.007 | -0.16 | 0.019 | 0.29 | 0.033 | 0.80 | 0.108 | 3.09* |
| $\beta_4$ | 0.046 | 1.35 | 0.071 | 1.60 | 0.075 | 1.82 | 0.085 | 2.99* |
| $\beta_5$ | 0.074 | 1.87 | 0.019 | 0.36 | 0.024 | 0.54 | -0.004 | -0.10 |
| $\beta_6$ | 0.020 | 0.63 | | | 0.003 | 0.06 | -0.058 | -1.08 |
| $\beta_7$ | -0.060 | -1.64 | | | -0.099 | -2.36* | 0.034 | 0.55 |
| $\beta_8$ | -0.066 | -1.96* | | | -0.037 | -0.91 | 0.002 | 0.04 |
| $\beta_9$ | 0.009 | 0.28 | | | 0.014 | 0.36 | 0.030 | 0.65 |
| $\phi$ | 8.088 | 4.18* | 7.150 | 3.80* | 7.043 | 4.22* | 6.509 | 13.17* |
| $\gamma_1$ | 4.466 | 3.84* | 2.797 | 2.73* | 2.195 | 2.60* | | |
| $\gamma_4$ | -0.624 | -0.52 | 0.071 | 0.06 | | | | |
| $\gamma_6$ | 0.570 | 0.50 | 0.261 | 0.23 | -0.086 | -0.10 | | |
| $\gamma_7$ | | | -0.229 | -0.26 | | | | |

Model Performance

| | $m0$ | $mb$ | $m2$ | $m2x^a$ |
|---|---|---|---|---|
| $R^2$ | 0.96 | 0.96 | 0.972 | 0.965 |
| $R^2$ adj. | 0.95 | 0.95 | 0.964 | 0.957 |
| S.E. | 1.76 | 1.78 | 1.563 | 1.720 |
| $F$-statistics | 96.60* | 117.76* | 132.924* | 127.027* |
| Log lhood | -128.00 | -130.658 | -120.261 | -128.141 |
| LM 1 (4) | 3.01 (3.91) | 4.56* (7.62) | 3.735 (9.859)* | 0.153 (1.951) |
| ARCH LM (lag) | 10.66 (1)* | 8.76 (1)* | 9.230 (1)* | 16.449 (1)* |
| Skewness | -0.002 | -0.371* | 0.093 | -0.143 |
| Kurtosis | 2.866 | 4.055* | 3.018 | 5.801* |
| Jarque-Bera | 0.052 | 4.786 | 1.001 | 22.79* |
| SC ($l$*) | 4.692 (9) | 4.585 (5) | 4.406 (9) | 4.5120 (9) |

*Note*: * significant at 5% or better level.

[a] Heteroskedasticity Consistent Covariances (White, 1980)

The exact order of the ARCH or GARCH models is determined by the same procedure employed for the DL model. Both, the $l$ and the SC, suggest the identical order of ARCH/GARCH models. The estimates of the ADL model expressed in Eq. (3.3) and corrected for ARCH effects are presented in Table 3.6.

Table 3.6 Maximum Likelihood Estimates of the ADL Model of Inflation

| | $m0$ | | $mb$ | | $m2$ | | $m2x^a$ | |
|---|---|---|---|---|---|---|---|---|
| | Coeff. | $t$-Stat. | Coeff. | $t$-Stat. | Coeff. | $t$-Stat. | Coeff. | $t$-Stat. |
| $c$ | 0.157 | 1.28 | -0.033 | -0.66 | -0.313 | -6.28* | -0.462 | -5.21* |
| $\alpha$ | 0.930 | 25.09* | 0.782 | 51.91* | 0.886 | 32.89* | 0.798 | 18.65* |
| $\beta$ | 0.029 | 1.00 | 0.046 | 3.30* | 0.017 | 0.95 | 0.028 | 0.99 |
| $\beta_1$ | -0.008 | -0.39 | 0.019 | 3.84* | 0.041 | 2.55* | 0.047 | 3.40* |
| $\beta_2$ | -0.033 | -1.61 | -0.022 | -3.33* | -0.064 | -3.19* | -0.010 | -0.68 |
| $\beta_3$ | -0.034 | -1.40 | -0.022 | -1.86 | 0.034 | 1.71 | 0.071 | 9.39* |
| $\beta_4$ | 0.015 | 0.76 | 0.029 | 3.13* | 0.068 | 6.01* | 0.070 | 5.89* |
| $\beta_5$ | 0.030 | 1.46 | 0.065 | 6.07* | 0.044 | 3.28* | 0.009 | 0.51 |
| $\beta_6$ | 0.007 | 0.78 | | | -0.027 | -1.94 | -0.036 | -1.91 |
| $\beta_7$ | 0.021 | 1.10 | | | -0.029 | -3.39* | 0.001 | 0.06 |
| $\beta_8$ | -0.048 | -2.18* | | | -0.026 | -1.94 | 0.004 | 0.30 |
| $\beta_9$ | -0.027 | -1.80 | | | 0.013 | 0.98 | 0.028 | 1.48 |
| $\phi$ | 6.930 | 1.54 | 8.926 | 0.39 | 6.657 | 0.72 | 7.418 | 34.88* |
| $\gamma_1$ | 0.952 | 1.69 | 1.539 | 6.12* | 1.400 | 6.07* | | |
| $\gamma_4$ | -0.558 | -1.34 | -0.718 | -4.13* | | | | |
| $\gamma_6$ | -0.007 | -0.02 | 0.091 | 0.77 | 0.502 | 2.79* | | |
| $\gamma_7$ | | | -0.236 | -2.91* | | | | |
| $\delta_0$ | -0.002 | -0.27 | 0.000 | 0.02 | 0.001 | 0.06 | 0.202 | 2.78* |
| $\delta_1$ | 0.275 | 1.74 | 2.684 | 4.18* | 2.319 | 3.90* | 1.456 | 4.95* |
| $\delta_2$ | | | | | -0.006 | -0.15 | | |
| $\lambda_1$ | 0.690 | 6.44* | | | | | -0.006 | -0.802 |
| **Model Performance** | | | | | | | | |
| $R^2$ | 0.941 | | 0.948 | | 0.962 | | 0.960 | |
| Adj. $R^2$ | 0.919 | | 0.934 | | 0.950 | | 0.949 | |
| S.E. | 2.357 | | 2.131 | | 1.858 | | 1.867 | |
| $F$-statistic | 44.014* | | 68.689* | | 76.679* | | 85.906* | |
| Log likelihood | -84.849 | | -91.242 | | -89.812 | | -100.484 | |
| Run Test sig. | 0.546* | | 0.043 | | 0.546* | | 0.118* | |
| Skewness | 0.176 | | 0.312* | | 0.054 | | 0.087 | |
| Kurtosis | 3.110 | | 2.548 | | 2.255 | | 2.837 | |
| Jarque-Bera | 0.389 | | 1.705 | | 1.632 | | 0.164 | |
| SC ($l$*) | 3.626 (9) | | 3.565 (5) | | 3.708 (9) | | 3.894 (9) | |

Q-statistics for the Standardized Residuals

| lag | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $m0$ | 1.19 | 1.25 | 1.30 | 1.42 | 1.51 | 1.57 | 1.57 | 3.04 | 3.54 | 4.65 | 5.26 | 5.43 | 5.49 | 8.11 | 8.12 | 8.82 | 10.61 | 10.61 |
| $mb$ | 0.64 | 0.65 | 0.66 | 0.94 | 1.26 | 1.32 | 5.89 | 6.15 | 6.89 | 9.95 | 10.06 | 10.08 | 10.27 | 10.62 | 10.63 | 10.67 | 10.72 | 10.72 |
| $m2$ | 0.42 | 1.19 | 1.85 | 4.55 | 4.61 | 4.86 | 5.05 | 5.11 | 5.19 | 6.50 | 7.23 | 7.84 | 8.61 | 12.09 | 13.44 | 15.52 | 16.59 | 21.81 |
| $m2x$ | 0.62 | 1.10 | 1.85 | 2.38 | 2.43 | 6.11 | 6.71 | 7.22 | 7.61 | 7.67 | 8.37 | 11.05 | 12.71 | 16.05 | 16.05 | 16.25 | 16.68 | 17.08 |

Q-statistics for the Squared Residuals

| lag | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $m0$ | 0.51 | 0.78 | 1.63 | 4.76 | 5.40 | 5.52 | 5.91 | 7.05 | 8.86 | 9.55 | 9.71 | 9.77 | 11.79 | 11.80 | 11.99 | 12.33 | 12.87 | 13.01 |
| $mb$ | 0.04 | 0.13 | 0.13 | 0.47 | 1.65 | 6.31 | 6.31 | 7.28 | 7.53 | 7.53 | 7.56 | 7.58 | 7.66 | 8.12 | 18.50 | 18.95 | 18.96 | 19.33 |
| $m2$ | 0.01 | 0.34 | 0.51 | 1.92 | 1.94 | 2.90 | 3.74 | 3.98 | 3.98 | 4.01 | 4.56 | 5.28 | 5.96 | 5.98 | 6.25 | 6.92 | 7.40 | 8.79 |
| $m2x$ | 0.95 | 1.37 | 1.39 | 3.95 | 3.97 | 3.99 | 4.89 | 6.33 | 7.58 | 7.58 | 8.09 | 9.60 | 10.40 | 11.21 | 11.24 | 11.58 | 12.09 | 16.41 |

*Note*: * significant at 5% or better level. [a] Heteroskedasticity Consistent Covariances (White, 1980), The ARCH LM test (not presented) and the Q-statistics of the residuals of each of the aggregates of the money supply do not reveal the presence of ARCH effects. Nevertheless, Table 3.6 illustrates that the performance of the models containing *m*0 and *mb* are somewhat inferior to the models including any of the broad money variables. Less generally, in the ADL model of inflation corrected for ARCH effects, there is no positive significant coefficient of *m*0 and the model containing *mb* seems to be plagued by autocorrelation. Even in the model containing *m*2, a number of negative values of the coefficients of money, of which two are significant, run counter to the postulates of economic theory. Hence, one may tentatively conclude that the ADL model containing *m*2*x*, corrected for ARCH effects, is a pretty good determinate of inflation in post-communist Russia.[74]

After estimating the DL and ADL models and learning that monetary aggregates *m*2 and *m*2*x* are the best proxies of inflation in these models respectively, we test to see if the inflation functions have undergone any structural change in these models.[75]. With that end in view, we subjected both models to the plethora of stability tests.[76] The results of these tests are somewhat mixed as demonstrated by a matrix of potential breaks in Table 3.7.

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[74] One cannot help noticing, however, that most of the explanation for the current rate of inflation in the model seems to be coming from the one month lagged inflation rate. A unit change in the previous month inflation rate seems to be determining as much as 80% of the variations in the current inflation rate. By the same token, the large value of the dummy *DO*94 may dwarf all other coefficients. Nonetheless, the exclusion of this dummy does not change much. The fit of the model deteriorates only slightly and the values of the longer lags become negative suggesting that model should be more parsimonious if this dummy is excluded. Indeed, the Wald test for redundant variables suggests the exclusion of lags longer than four in the new specification.

[75] The usefulness of equations like those estimated here for policy purposes hinges crucially on the temporal stability of the equation parameters. However, stability of the model coefficients is a necessary but not a sufficient requirement for the model to be a useful tool for policymakers. This issue is discussed further in Nikolić (2000b).

[76] The tests include: recursive residuals test (RRT), one step forecast test (O-SFT), N-step forecast test (N-SFT), scaled recursive Chow test (SRCT), Chow forecast test (CFT) and finally the recursive OLS coefficient test (ROLSCT). Since these tests may be used with OLS and the two-stage OLS regressions, they are performed on the DL and ADL models presented in the Tables 3.3 and 3.5 respectively, after omitting variable *DO*94 from the estimation for computational reasons. In order to conserve space only the O-SFT and the SRCT are presented.

Table 3.7 Significant Scaled Recursive Chow and One-Step Forecast Stability Tests

| | Jan-94 | Feb-94 | Mar-94 | Apr-94 | May-94 | Jun-94 | Jul-94 | Aug-94 | Sep-94 | Oct-94 |
|---|---|---|---|---|---|---|---|---|---|---|
| *m*2 (DL) | 1.16 | 1.18 | 1.2 | 1.16 | 1.15 | 1.18 | 1.05 | 1.00 | | 1.01<br>(6.64) |
| *m*2*x* (ADL) | | 1.27 | | | | | | | | (6.08) |

*Note*: The values in parenthesis are the O-SFT values of the recursive residuals that lie outside the two standard error bounds. As the Chow statistic and the critical values of $F$ are functions of time, we divided the Chow value by its 5 percent critical value from the tables of $F$ to yield a SRCT for recursion. Values of this statistic greater than unity imply that the null hypothesis of no structural change between periods $t$-1 and $t$ would be rejected at the 5 percent level of significance.

All of the stability tests, based on recursive estimations, indicate that both models provide a poor fit for the October 1994 observation. These findings are suggestive of either an outlier or exceptional value for $\pi_t$ or an alteration in the structural parameters of the model. Thus, inclusion of the dummy variable, *DO*94, for October 1994 seems justifiable. However, the SRCT indicates a lack of stability for the parameters of *m*2 in the DL model throughout 1994. Similarly, the SRCT is suggestive of a structural break in February and in October 1994 for the ADL model including *m*2*x*. It is not obvious to what extent the inclusion of the *DO*94 dummy affects stability of parameters in the models, since these tests cannot be applied with this dummy included. In order to overcome this difficulty, we applied the dummy variable, in the additive form, technique to test for structural stability. The dummy takes a value of 1 for the observations of and after the suspected structural break and zero otherwise. The results of this test do not justify rejection of the null hypothesis of no structural break in 1994 in the DL model including *m*2 and the *DO*94 dummy. Hence, the DL model involving *m*2 has no structural break and it is a reasonably good representation of inflation. In contrast, the same test points to a structural break in February 1994 for ADL including *m*2*x*. The latter result is hardly surprising given that the Perron's (1989) test presented above suggested a structural break in the inflation series in February 1994. Hence, after accounting for the structural break, and after the implementation of the exact order of the ARCH term, the best final ADL model of inflation that includes *m*2*x* turned out to be ARCH(1,0); it is presented in Table 3.8.[77]

[77] In order to make the model more parsimonious, the Wald test for redundant variables is applied. This justifies the exclusion of the variables of *m*2*x* with lags longer than 4 months since their coefficients are jointly not different from zero.

Table 3.8 ARCH(1,0) ADL Model of Inflation Involving m2x

| | $c$ | $\alpha$ | $\beta$ | $\beta_1$ | $\beta_2$ | $\beta_3$ | $\beta_4$ | $\phi$ | $\xi$ | $\delta_0$ | $\delta_1$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Coeff. | 4.819 | 0.648 | 0.011 | 0.084 | -0.049 | 0.035 | 0.102 | 10.461 | -4.842 | 0.248 | 1.151 |
| $t$-Stat. | 8.90* | 25.27* | 0.60 | 3.77* | -1.80 | 1.55 | 6.69* | 4.53* | -11.18* | 1.86 | 3.16* |

| $R^2$ | Adj.$R^2$ | S.E. | $F$ | Log | Run | Skew. | Kurto | J-B | SC | ($l$*) |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.924 | 0.912 | 2.467 | 76.46* | -119.38 | 0.251* | 0.271 | 2.505 | 1.662 | 3.866 | 4 |

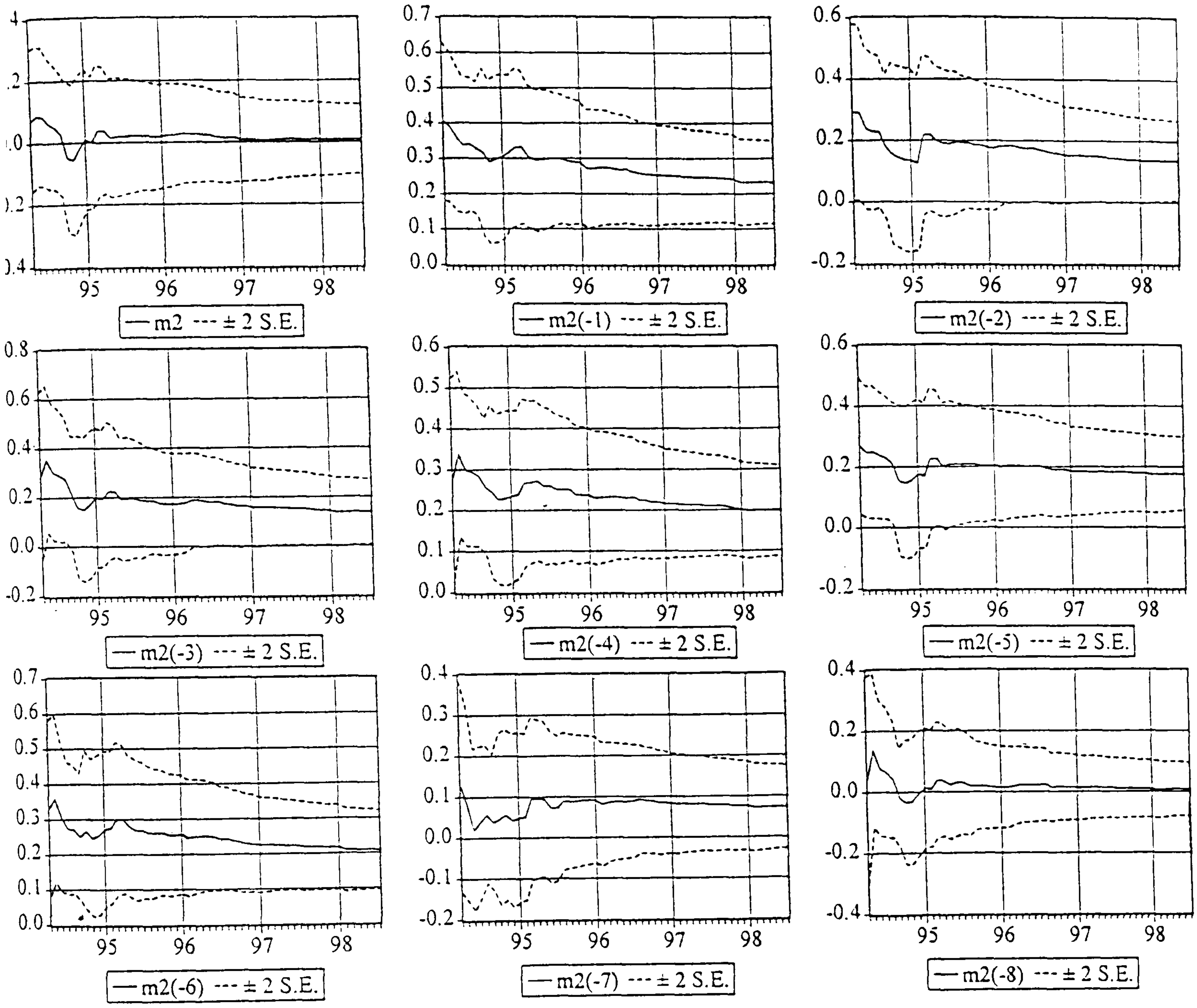
| lag | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q-stnd. res. | 3.44 | 3.60 | 5.12 | 7.93 | 9.83 | 11.87 | 11.87 | 12.76 | 12.77 | 12.78 | 13.18 | 13.18 | 13.34 | 13.44 |
| Q-sq. res. | 0.57 | 2.25 | 3.68 | 3.68 | 3.78 | 6.04 | 6.94 | 8.79 | 8.81 | 8.81 | 9.55 | 9.59 | 11.63 | 11.77 |

*Note*: * significant at 5% or better level. $\xi$ is a coefficient of the dummy for structural break in February 1994.

The time path of the recursive OLS estimates reveals that, after initial instability of the parameters estimates due to the small number of observations, all of the money coefficients of the variables in the DL and ADL models are either constant or slightly declining over time. This could be seen unambiguously from Fig. 1 for the DL model involving $m2$, which adds to the evidence of the diminishing influence of money on prices.[78]

[78] Only coefficients of the DL model are presented since it may be argued that the lagged inflation rate in the ADL model would impose a geometrically declining lag structure which smoothes out short-term fluctuations in money supply and consequently affects the distribution of the coefficients of money. A dummy variable, *DO*94, is omitted from the estimation for computational reasons.

Fig. 3.1 Recursive Coefficient Estimates of *m*2 in the DL Model



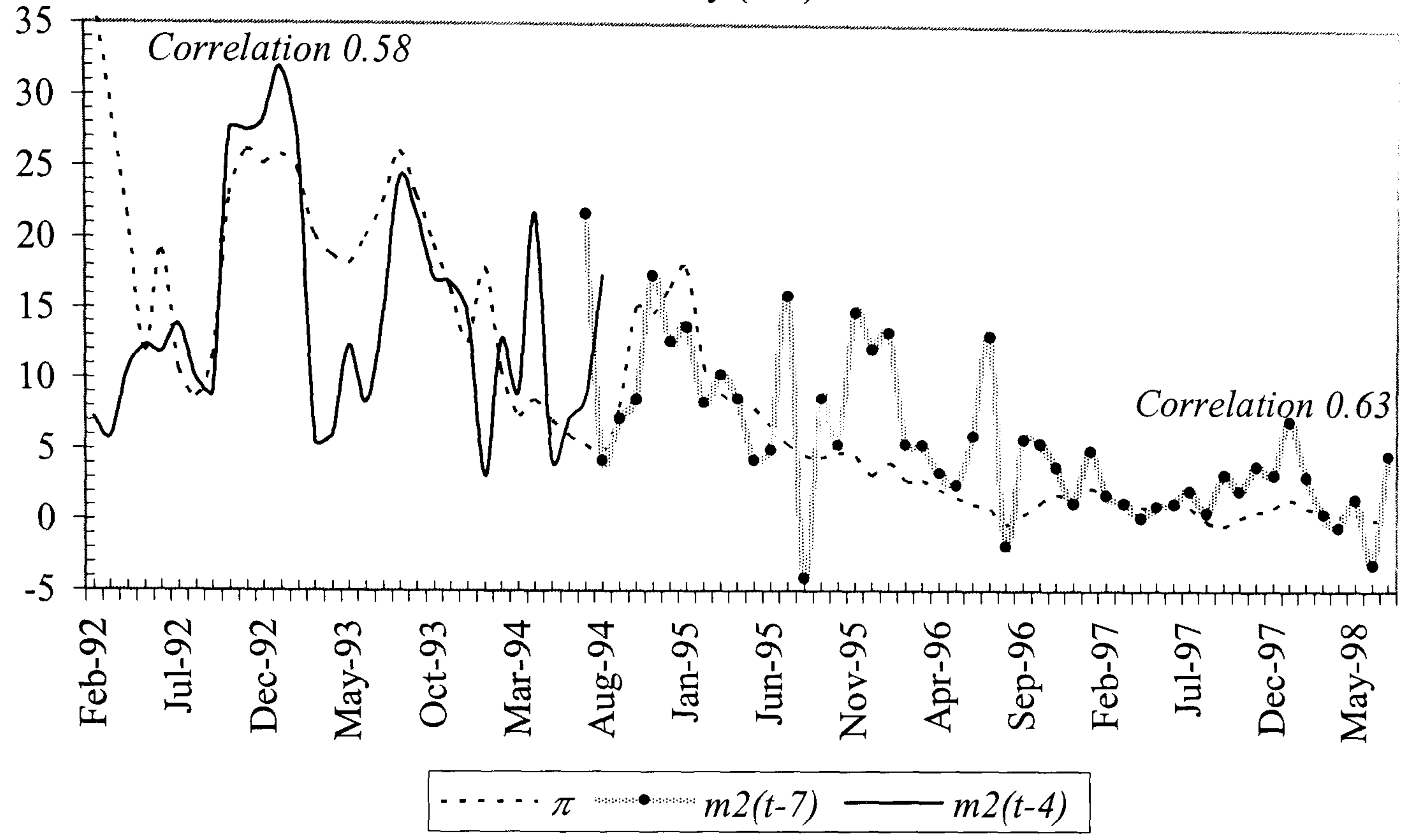
### 3.5 Breaking up the Sample

In order to compare the influence of the money supply on inflation over the two phases of transition, we divided the sample into two parts. The first part (I) includes the observations before October 1994 and the second (II) the observations thereafter.[79] The choice of the split point is inspired by the observation that the O-SF test indicates existence of a structural break in the models in October 1994.[80] Furthermore, it has been claimed (Hoggarth, 1996; RET, 1994) that inflation, in the second half of 1994, started to follow the six months lag in $m2$ growth instead of a three to four months lag in the 1992 to 1993 period. In order to verify these claims, we plotted the most highly correlated lags of broad money growth with the inflation rate for the two subperiods. Visual inspection of Fig. 2 and utilization of the correlation statistics, suggests that not only has a shift occurred in the second part of 1994, but also the lagged response of prices to money has become even longer than six months. Indeed, the correlation coefficients ($r$) between inflation and lagged money growth depicted in Fig. 2 suggest that the dominant response of the former to the growth of latter has shifted from the four months ($r$=0.59) prior to the late summer of 1994 to seven months ($r$=0.62) thereafter. Incidentally or not, the split point appears to be near enough to the time that Russia embarked on a path of relatively sustained monetary stability, which may arguably be taken as a break in the economic policy regime.

[79] The October 1994 observation is omitted since it's very large value needs to be modelled by introducing a dummy as explained above. Inclusion of this variable may, not only dwarf other values of the parameters but it also reduces the degrees of freedom in the relatively small sub-samples.

[80] Arguably, an alternative date for the split point could be February 1994, as indicated both by the SRCT for ADL model and the observation that the inflation rate has a structural break in this period. However, the preference for the October 1994 is guided by a practical consideration. Namely, an earlier date would reduce an already small sample and make analyses of period (I) much less reliable.

Figure 3.2 Correlation Between Inflation ($\pi$) and Lagged Ruble Broad Money ($m2$)




The OLS estimates of the DL model involving $m2$ and $m2x$ for the two subperiods, presented in Table 3.9, reveal that only $m2$ in period (I) seems to represents the inflation process.[81] Thus, the model for period (I) seems to have all desirable properties of economic and statistical theory. The fit of the model is fairly good, all of the significant coefficients of money are positive, and the diagnostic statistics do not indicate any model deficiency.

[81] The models of the split samples involving $m0$ and $mb$ are not presented since these two aggregates have not proved to be good proxies of inflation.

Table 3.9 OLS of the First Differences of the DL Model of Inflation in the Sub-periods

| | *m2* | | | | *m2x* | | | |
|---|---|---|---|---|---|---|---|---|
| | 1992:2 94:09 | | 1994:11 98:07[a] | | 1992:2 94:09 | | 1994:11 98:07 | |
| | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. |
| $\beta$ | 0.025 | 0.25 | 0.015 | 0.327 | -0.066 | -0.75 | 0.085 | 1.83 |
| $\beta_1$ | 0.328 | 3.47* | 0.135 | 1.600 | 0.002 | 0.02 | 0.214 | 3.19* |
| $\beta_2$ | 0.180 | 1.53 | 0.021 | 0.301 | -0.020 | -0.20 | 0.049 | 0.67 |
| $\beta_3$ | 0.213 | 1.81 | -0.006 | -0.103 | 0.106 | 1.12 | 0.062 | 0.85 |
| $\beta_4$ | 0.257 | 3.06* | 0.075 | 1.170 | 0.109 | 1.17 | 0.158 | 2.18* |
| $\beta_5$ | 0.211 | 2.10* | 0.096 | 1.182 | 0.116 | 1.35 | 0.187 | 2.61* |
| $\beta_6$ | 0.250 | 2.77* | 0.128 | 1.598 | -0.048 | -0.53 | 0.179 | 2.63* |
| $\beta_7$ | 0.039 | 0.46 | 0.115 | 1.737 | 0.031 | 0.41 | 0.142 | 2.21* |
| $\beta_8$ | -0.018 | -0.22 | 0.060 | 1.270 | -0.021 | -0.30 | 0.065 | 1.40 |
| $\gamma_1$ | 3.668 | 1.73 | 0.855 | 1.234 | | | | |
| $\gamma_6$ | -0.651 | -0.34 | -0.597 | -1.521 | | | | |
| | | | Model Performance | | | | | |
| $R^2$ | 0.707 | | 0.379 | | 0.394 | | 0.405 | |
| Adj. $R^2$ | 0.463 | | 0.196 | | 0.048 | | 0.272 | |
| S.E. | 2.221 | | 1.113 | | 2.956 | | 1.059 | |
| *F*-statistic | 2.894* | | 2.073 | | 1.140 | | 3.06* | |
| Log likelihood | -43.509 | | -62.365 | | -51.853 | | -61.403 | |
| D.W. | 1.667 | | 1.262 | | 2.214 | | 1.190 | |
| Runs test (sig.) | 0.763* | | 0.058* | | 0.498* | | 0.038 | |
| LM 1 (4) | 0.16 (4.42) | | 4.748* (9.065) | | 0.00 (1.387) | | 7.439* (8.497) | |
| ARCH LM (lag) | No | | 23.858 (4)* | | No | | 4.40 (1)* | |
| SC ($l$*) | 4.28 (8) | | 3.70 (8) | | 5.736 (8) | | 4.227 (8) | |
| | | | Summary statistics | | | | | |
| Long run mult. | 1.485 | | 0.639 | | 0.209 | | 1.142 | |
| Mean Lag | 3.392 | | 4.675 | | 5.042 | | 4.079 | |

Q-statistics of the Standardized and Squared Residuals

| Lag | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *m* 2 ( I ) | Q- St. res. | 0.25 | 3.79 | 4.64 | 4.69 | 4.99 | 5.28 | | | | | |
| | Q- Sq. res. | 0.41 | 0.44 | 0.52 | 2.76 | 2.79 | 3.94 | | | | | |
| *m*2 (II) | Q- St. res.. | 5.52* | 6.58* | 6.59 | 7.07 | 7.09 | 7.10 | 7.27 | 8.03 | 8.38 | 8.40 | 11.52 |
| | Q- Sq. res. | 3.75 | 5.22 | 5.23 | 5.23 | 5.23 | 5.33 | 5.34 | 5.35 | 5.42 | 5.90 | 5.91 |
| *m2x* (I) | Q- St. res. | 1.22 | 1.23 | 2.79 | 3.15 | 3.55 | 3.56 | | | | | |
| | Q- Sq. res. | 3.46 | 5.54 | 5.71 | 6.87 | 7.75 | 9.00 | | | | | |
| *m2x* (II) | Q- St. res. | 7.60* | 7.62* | 7.93* | 7.97 | 7.98 | 9.28 | 10.73 | 11.11 | 11.23 | 11.24 | 11.77 |
| | Q- Sq. res. | 4.77* | 5.24 | 5.25 | 5.35 | 5.35 | 5.55 | 5.63 | 5.76 | 5.80 | 6.17 | 8.16 |

*Note*: An asterisk indicates significance at 5 per cent or better level.

[a] Heteroskedasticity Consistent Covariances (White, 1980)

Table 3.9 also reveals that both aggregates of broad money supply introduce ARCH effects in period (II). However, the specification applied to the entire period may not be appropriate for the subperiods. Hence, a new search for both the optimal lag structure using the SC, and the exact order of the ARCH model for the two subperiods is performed. These tests indicate that the model involving $m2$ in period (I) that is presented in Table 3.9 is the optimal specification. The remaining specifications and the estimates are presented in Table 3.10.

Table 3.10 Maximum Likelihood Estimation of the DL Model of Inflation for the Subperiods

| | *m*2 | | *m*2*x* | | | |
|---|---|---|---|---|---|---|
| | 1994:11 98:07[a] | | 1992:2 94:09 | | 1994:11 98:07 | |
| | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. | Coeff. | *t*-Stat. |
| $\beta$ | 0.009 | 0.35 | -0.163 | -0.17 | 0.004 | 0.12 |
| $\beta_1$ | 0.047 | 2.22* | -1.274 | -1.50 | 0.064 | 2.11* |
| $\beta_2$ | | | 0.762 | 1.32 | | |
| $\beta_3$ | | | -0.299 | -0.62 | | |
| $\beta_4$ | | | 0.659 | 1.28 | | |
| $\beta_5$ | | | 0.603 | 1.30 | | |
| $\beta_6$ | | | 0.363 | 1.76 | | |
| $\beta_7$ | | | 0.173 | 0.52 | | |
| $\beta_8$ | | | 0.482 | 2.32* | | |
| $\beta_9$ | | | 0.083 | 0.58 | | |
| $\beta_{10}$ | | | 0.133 | 0.61 | | |
| $\beta_{11}$ | | | -0.275 | -1.82 | | |
| $\beta_{12}$ | | | 0.104 | 0.34 | | |
| $\beta_{13}$ | | | -0.244 | -1.40 | | |
| $\beta_{14}$ | | | 0.134 | 1.08 | | |
| $\gamma_1$ | 0.406 | 1.90 | | | | |
| $\gamma_6$ | -0.254 | -2.65* | | | | |
| $\delta_0$ | -0.005 | -0.69 | | | 0.002 | 0.18 |
| $\delta_1$ | -0.103 | -1.73 | | | -0.102 | -1.42 |
| $\lambda_1$ | 1.046 | 10.48* | | | 1.036 | 8.53* |
| $R^2$ | 0.125 | | 0.942 | | 0.140 | |
| Adj. $R^2$ | -0.013 | | 0.537 | | 0.054 | |
| S.E. | 1.249 | | 2.216 | | 1.208 | |
| *F*-statistic | 0.908 | | 2.328 | | 1.625 | |
| Log likelihood | -42.714 | | -19.459 | | -46.206 | |
| D.W. | 1.364 | | 3.229 | | 1.342 | |
| LM 1 (4) | NA | | 13.556* (-) | | NA | |
| ARCH LM | No | | No | | No | |
| SC (1*) | 2.49 (1) | | 4.789 (14) | | 2.477 (1) | |

Q-statistics of Standardized and Squared Residuals

| lag | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *m*2 (II) | Q- St. res. | 3.90* | 4.14 | 6.62 | 7.38 | 7.51 | 7.72 | 7.72 | 7.76 | 7.93 | 8.22 | 8.30 |
| | Q- Sq. res. | 0.52 | 1.22 | 2.56 | 2.72 | 2.80 | 3.71 | 4.28 | 4.83 | 4.95 | 7.09 | 7.63 |
| *m*2*x* (I) | Q- St. res. | 8.26* | 14.34* | 15.59* | 16.09* | | | | | | | |
| | Q- Sq. res. | 3.82 | 3.82 | 3.84 | 3.84 | | | | | | | |
| *m*2*x* (II) | Q- St. res. | 2.25 | 2.25 | 2.84 | 3.29 | 3.65 | 4.32 | 4.52 | 4.63 | 4.73 | 4.75 | 4.76 |
| | Q- Sq. res. | 0.14 | 1.42 | 1.48 | 1.54 | 1.75 | 2.66 | 2.78 | 3.57 | 3.57 | 5.16 | 5.25 |

*Note*: An asterisk indicates significance at 5 per cent or better level.

[a] Bollerslev-Wooldrige (1992) robust standard errors & covariance

Although the results from the SC lag selection are not reported, Table 3.10 indicates that this criterion chooses the model of inflation including only a current and one month lagged values of either *m*2 or *m*2*x*. After correction for ARCH effects, the model does not comply with economic theory. Namely, although individual coefficients of lagged values of both aggregates of broad money are individually significant, the overall significance of the coefficients (*F*-test) of all monetary aggregates for two sub-periods is not different from zero. Hence, these statistics indicate that there is no a stable linear relationship between inflation and *m*2*x* in period (I) nor between inflation and either of *m*2 or *m*2*x* in period (II).

In order to capture the intensity and the speed of transmission of monetary impulses to future inflation, we used several measures of summary statistics. These statistics, reported in Table 3.9, reveal important differences between the estimates with respect to the strength of the influence of the models' coefficients on the dependent variable in the two subperiods. The subsequent analysis focuses on *m*2, since this monetary aggregate in a DL model, despite its shortcomings associated with period (II), outperforms other aggregates in explaining inflation. Noticeably, the percentage of the total variation in the inflation rate explained by the regression model ($R^2$) for period (I) is almost twice as much of its corresponding value for period (II). The estimates of the coefficients of *m*2 are also considerably greater for period (I) than the corresponding estimates in period (II). This difference is equal to the difference of the long run multipliers (lrm), which are in fact sums of the coefficients of money. The lrm represents the change in the long run value of inflation caused by a unit increase in the growth of money supply. The value of lrm of 1.49 for *m*2 in period (I) indicates that a one percent increase in the growth of *m*2 is reflected in a 1.49 percent increase in prices. The lrm in period (II) is considerably lower (0.639) with a noticeably smaller impact on the inflation rate, as the examination of the recursive coefficients' estimates presented in Fig. 1 suggest. Moreover, the lrm in period (II) is not statistically different from zero. However, even though the lrm seem to be notably different from 1 in both subperiods, the Wald test cannot reject the null hypothesis of *m*2 being reflected in prices one-for-one for either of the periods, nor indeed for the entire period.[82]

The summary statistics presented in Table 3.6 also give a tentative indication of the lengthening of a lag between money and prices. As a measure of the speed, the mean lag (ml), expressed in the number of months with which prices respond to money on average,

[82] The test produces Chi-square statistics for periods (I) and (II) of 0.517 and 0.625, respectively. The corresponding statistics for the entire period is 0.439.

appears to be significantly greater (4.68) in period (II) than in period (I) (3.39).[83] Similarly, while the inflation rate has the highest correlation with money growth four months earlier in period (I) (0.318), the highest correlation in period (II) (0.624) is with money growth seven months earlier, as shown in Fig. 2.[84]

### 3.6 Conclusion

Our analysis of the relationship between various monetary aggregates and inflation supports earlier claims that, broad money growth appears to have the strongest correspondence to contemporary inflation in post-communist Russia. However, this relationship proved to be unstable, and sensitive to changes taking place in the new economic and institutional environment. In addition to other evidence about changes in this relationship, the summary statistics presented in the chapter suggests that, the average speed of transmission from changes in the growth of ruble broad money to inflation have increased from just over three months to just short of five months as Russia has embarked on a path of macroeconomic stability soon after the exchange rate crises of October 1994. Similarly, the summary statistics also reveal that, changes in the growth of the broad money had a considerably greater impact on prices in the period before October 1994, than in the period thereafter. Furthermore, the lack of overall significance of the coefficients of money in this later period points to a break in the systematic pattern of money price relationship, which was observed two and a half years after price liberalization in Russia. In contrast, the impact of changes in the previous month's inflation rate on current inflation does not abate. The overwhelming influence of this impact signifies the existence of the considerable inflation inertia prevalent in the Russian economy and the persistence for inflation shocks. This result calls for the inclusion of the one-month lagged inflation variable in the inflation model. Hence, the ADL model of inflation including $m2x$ avoids the shortcomings of some

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[83] The corresponding statistics for the entire period is 3.56 months. The magnitude of the calculated mean lags for periods (I) and (II), obtained by OLS 'unremedied' estimates, and their difference is not substantially different from the 'remedied' estimates. A similar DL model except for the ARCH term is given by Carlson (1980) for the American economy for 1955-1979 period.

[84] The corresponding statistic for the entire period is 0.654 for lag of four months. For this particular exercise, the lag estimates of $m2$ prior to February 1992 are taken into consideration. The largest $r$ for inflation and $m2$, if observations of $m2$ prior to February 1992 are excluded, applies to a lag of five months for both, period (I) and the entire period, while the highest $r$ for period (II) is for a lag of seven months as reported.

of the representations in the previous literature. This model also provides a reasonably good short hand description of the fundamental inflation process in Russia.

Even though our sample period of six and a half years, is the longest considered so far, it may still be considered too short for meaningful analysis, particularly in these times of major transformation of not only the economic system but also the entire country or region. In addition, as pointed out by many researchers, Russian statistics must be used cautiously so that we should not rule out the possibility of model misspecification due to erroneous data. Therefore, the conclusions drawn from this analysis rest on the adequacy of the sample length and the accuracy of the data for model specification.

# CHAPTER 4

# Money - Inflation Causality in Transition Economies: The Case of Russia

## 4.1 Introduction

Despite numerous empirical studies devoted to role of money in the evolution of real market economy, the topic has endured considerable controversy as the new economic environment was created in the former socialist economies of Central and Eastern Europe. Among unsettled policy issues that have unwittingly been extended to transition economies are those related to Granger causality testing and inevitably, suitability of the applied macroeconomic stabilizations. The objective of this study is twofold; it aims to shed some additional light to the issue of the choice of lag selection criteria in causality testing on one hand, and the issue of suitability of monetary aggregates for influencing and controlling inflation via policy instrument, in transition economies like the Russian Federation, on the other.[85]

At one end of the spectrum of opinions on monetary policy, money is viewed only as a passive adaptor to business condition with a little independent influence. At the other end, an opposing hypothesis holds that monetary actions, as measured by movements in the monetary aggregates, have lasting effects on nominal variables like GNP, output and a price level. An influential tenet of the latter school of thought, branded monetarism, is the view that inflation, as a persistent increase in the general level of prices, results solely from maintained expansion of money stock at rates in excess of increase in the amount of money demanded in the economy. In contrast to empirical evidence in support of monetarist views for majority of market economies, no systematic pattern for the money price relationship was detected in transition economies, except for Russia and Poland, thus undermining the

[85] Inflation was chosen to be a goal variable since the two main goals of economic policy, full employment and price level stability, are directly linked to nominal GNP. In many transition economies, taming inflation was often proclaimed to be the chief objective of economic policy. This arguably unidimensional goal was advocated and to the extent dictated by the IMF. However, Gross National Product or Gross Domestic Product could be used as a goal variable, or indeed could be incorporated into current analysis without difficulties.

conventional monetarist view, at least in the transitional context (Economic Commission for Europe, 1995). If indeed this were the case, it would imply among other things, that traditional tools used for stabilization and control of inflation in advanced market economies may not be appropriate for transition economies. Given that it is well established that high inflation is costly in terms of a loss of output in transition economies (Fisher *et al.*, 1996), inappropriate policies to combat inflation may not only be detrimental to a current welfare of societies in transition, but also may cause unnecessary delay in the transition process which in turn, may also exacerbate the loss of welfare in the long run.[86]

Suitability of monetary policy, in particular the issue of appropriateness of monetary targeting in the transition economy like the Russian Federation, is best settled by empirically testing the usefulness of aggregates of money supply as an intermediate target for controlling inflation. In practice, an intermediate target is effective if it (i) has a significant explanatory power in determining goal variable, (ii) is exogenous or causally prior to the goal of policy actions, and (iii) could be reasonably controllable by policymakers. Since the first of theses criteria appears to have been fulfilled, at least in the early years following price liberalization, it remains to be determined whether broad money aggregates are causal prior to inflation in Russia, and should it prove so whether are controllable by policymakers.[87]

The outcome of an empirical investigation of the causal relationship between money supply and inflation, or indeed any other macroeconomic variable e.g., income, seems to be largely determined by the choice of the length of their distributed lags in a bivariate model. Despite numerous empirical studies, e.g., Hsiao (1981); McMillin and Fackler (1984); Thornton and Batten (1985); Jones (1989), the jury on the verdict of superiority of criteria for the selection of a lag length in causality testing is still out. On one hand, Hsiao (1981) and Thornton and Batten (1985) claimed that the statistical criterion given by Akaike

[86] The International Monetary Fund (IMF) mission in Moscow argued that high inflation would be detrimental to Russian economy in many ways, e.g., it would generate uncertainty about key prices, including real interest and exchange rates, which in turn would deter long-term credit, investment, and growth. In addition, high inflation would be damaging to economy by encouraging unproductive activities aimed only at hedging against inflation. Furthermore, high inflation would be hurting the most deprived social group, which lacks political strength to protect their real income against rising prices. Finally, high inflation would contribute to a general climate of uncertainty and lack of trust in government policies, all of which would encourage speculation against the ruble and capital flight (Hernández-Catá, 1995).

[87] Many researchers, e.g., Nikolic (2000), claimed that broad money aggregates (potential intermediate target) have a significant explanatory power in determining inflation (goal variable) in Russia in the years after the price liberalization of February 1992. Nikolić (2000a) however, showed that the influence of the variation in the former on the latter became considerably weaker and more protracted as financial system became more sophisticated and macroeconomic environment more stable.

(1970) was superior not only among the other statistical criteria but also over the ad hoc specifications, which are most common in literature. On the other hand, Jones (1989) disputed their claims favouring one of the ad hoc criteria and implying that the results obtained by Thornton and Batten (1985) were data specific. It seems that a good way of settling such a controversy may be to utilize an independent data set, e.g., for Russia instead of the United States, and evaluate the empirical results obtained by various criteria as well as an extensive portion of a lag space. Thus, this analysis amounts to a great extent to an empirical testing of the monetarist paradigm that money supply, in a transition economy, causes inflation without a feedback.

The reminder of this section is organized as follows. Section 2 discusses the data and methodology employed in the analysis. In section 3 the model and the criteria for its selection are outlined. The empirical results are reported and discussed in section 4, while section 5 briefly reviews a few considerations related to the Russian experience with monetary targeting. Finally, section 6 concludes with the summary of the findings.

### 4.2 Data and Methodological Overview

As in the most previous analysis of inflation and money supply processes in Russia, this study was conducted using data published by the *Russian Economic Trends* (RET). The choice of monetary variables was based on the findings (Nikolić, 2000a) of the significant systematic pattern of the money supply-inflation relationship in the early years after the price liberalization of January 1992. The data consist of monthly observations of the Consumer Price Index (*CPI*), ruble broad money (*M*2), and extended broad money (*M*2*X*), from February 1992 to July 1998. *M*2 is defined as the sum of currency outside banks, as reported by the Central Bank's of Russia (CBR) Money Circulation Department, and ruble deposits in the banking system defined as the sum of demand, savings and time deposits of enterprises, the state insurance company, voluntary organizations, individuals, and deposits for long-term capital investment, but excluding deposits of the enlarged government. *M*2*X* comprises *M*2 and the foreign exchange deposits with commercial banks.

As an empirical work on time series requires, all of the variables were examined for stationarity and cointegration. As expected, no variable in its original form was found to be stationary, nor were any of the original time series of either monetary aggregate cointegrated with the *CPI*. In order to obtain stationary time series, we employed the growth rates of each individual variable, which is approximately equivalent to combining differencing transformation, or operator as it is often termed, with power transformation[88]. Since policy deliberations are couched in terms of growth rates, use of the growth rates seems appropriate. The growth rates of each time series (*CPI*, *M2*, and *M2X*), denoted as $\pi$, $m2$ and $m2x$ respectively, were checked for the existence of a unit root by standard augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. In addition, since the standard unit root tests are not very powerful, i.e., they cannot distinguish between unit roots and near unit root stationary processes, we employed a more powerful test, which tests the null hypothesis of stationarity against the alternative of a unit root. The test is a recent work of Kwiatkowski, Phillips, Schmidt, and Shin (1992), after whom is named the KPSS test. The results of the standard unit root tests, as well as the KPSS test for stationarity, are presented in table 1.

Table 4.1 Unit Root Tests: 1992:02-98:07

| $l$ | $\pi$ | | | $m2$ | | | $m2x$ | | |
|---|---|---|---|---|---|---|---|---|---|
| | ADF | PP[a] | KPSS | ADF | PP[a] | KPSS | ADF | PP[a] | KPSS |
| 1 | -4.07 | -4.46 | 0.179 | -4.96 | -6.62 | 0.056 | -4.835 | -5.924 | 0.141 |
| 2 | -3.86 | -4.38 | 0.138 | -5.67 | -6.67 | 0.050 | -4.303 | -5.932 | 0.122 |
| 3 | -3.49 | -4.46 | 0.120 | -5.96 | -6.60 | 0.050 | -4.133 | -5.928 | 0.114 |
| 4 | -4.44 | -4.51 | 0.111 | -7.00 | -6.55 | 0.054 | -4.336 | -5.941 | 0.111 |
| 5 | -3.12 | -4.51 | 0.108 | -4.71 | -6.43 | 0.066 | -3.255 | -5.865 | 0.114 |
| 6 | -2.47 | -4.49 | 0.108 | -4.02 | -6.41 | 0.080 | -2.525 | -5.813 | 0.117 |
| 7 | -1.94 | -4.45 | 0.110 | -3.88 | -6.44 | 0.096 | -3.077 | -5.828 | 0.117 |
| 8 | -2.18 | -4.41 | 0.112 | -4.00 | -6.47 | 0.108 | -5.453 | -5.875 | 0.115 |
| 9 | -2.56 | -4.39 | 0.114 | -2.93 | -6.50 | 0.115 | -5.604 | -5.902 | 0.113 |
| 10 | -2.29 | -4.36 | 0.116 | -2.37 | -6.48 | 0.114 | -3.635 | -5.912 | 0.112 |

*Note*: [a]Lag truncation ($l$) for Bartlett kernel for $\pi$, $m2$, and $m2$x is 10, 1, and 3, respectively, while Newey-West (1987) suggests 3 for all series.

Critical values for the tests are as follows:

| | ADF | PP | KPSS |
|---|---|---|---|
| 1% | -4.082 | -4.080 | 0.216 |
| 5% | -3.469 | -3.468 | 0.146 |
| 10% | -3.161 | -3.161 | 0.119 |

[88] See Nikolić (2000a).

All of the ADF test statistics were obtained by inclusion of a constant and a linear time trend (*trend*) into regressions. It appeared that the ADF statistics were sensitive to the choice of a truncation lag ($l$) for the inflation series. Critical values for the ADF test including a constant and a linear trend term clearly allowed rejection of a null hypothesis of a unit root for the first four lags at a conventional level of significance.[89] Following Perron (1989), $l$ was selected if the $t$-statistic on the coefficient of a lagged difference of a dependent variable ($\chi_i$) was greater than 1.60 in absolute value, and the $t$-statistic on $\chi_i$ for $i>l$ was less than 1.60. This procedure yielded $l$=4 for which the null of a unit root could be rejected at the conventional level of significance. However, the Schwarz Criterion (SC) for determination of an optimum $l$ suggested the lag 8, for which the null of a unit root could not be rejected. Nevertheless, neither the constant nor the trend term were significant in this specification (or indeed for any $l$>4) indicating misspecification of the deterministic part of the regression. Furthermore, as shown by Nikolić (2000a), the inflation rate time series might have had a structural break at the beginning of 1994 when the inflation rate decreased markedly without a significant change in the trend (slope) over the period. Applying the modified unit root test (Perron, 1989), the previous assumption concerning the structural break was confirmed and the unit root hypothesis rejected. Following Perron's proposed unit root test, a dummy variable $D_u$ was included to account for a potential structural break. Hence, the following regression was estimated:

$$\Delta\pi = \underset{(4.59)}{15.32} - \underset{(3.71)}{0.15}trend - \underset{(4.23)}{4.52}D_u - \underset{(4.88)}{0.61}\,\pi_{-1} + \sum_{i=1}^{9}\chi_i\Delta\pi_{-1} \tag{4.1}$$

where $D_u$ is a dummy variable so that $D_u$=1 after January 1994 and 0 otherwise, while $t$-ratios are in the brackets. The values of the test statistics for the Dummy variable (4.23) and for the one period lagged inflation (4.88) imply a structural break and the rejection of a unit root, respectively. Hence, based on both, the ADF and the PP test statistics, the inflation series proved to be a trend stationary process. Similarly, $m2$ is also found to be a trend stationary process since both, the Perron's method ($l$=2) and the SC ($l$=4) chose truncation lags that produced the ADF and the PP statistics that rejected the null of a unit root. The same reasoning applied to the $m2x$ series since the Perron's method and the SC chose $l$=4

[89] The conventional level of significance throughout this paper is taken to be 5%.

and $l$=10, respectively, for both of which the null of a unit root was also rejected. Equally important, the KPSS test statistics could not reject the null hypothesis of stationarity for any of the series at any tested truncation lag length, except for the lag 1 in the inflation series. This last point did not question the acceptance of stationarity even for the inflation series. This is because a conventional, the so-called $l8$ rule, $l$=INT[8(T/100)$^{1/4}$] suggested by the KPSS authors, set $l$ to equal 7, so that the hypothesis of stationarity could not be rejected. Hence, all the series under consideration were found to be trend stationary.

In order to examine seasonality patterns in the data, all variables were regressed against a constant, a trend, and the seasonal dummies, $D_i$'s. A seasonal dummy, $D_i$, was set to equal 1 for the month in which seasonal variation was observed and 0 otherwise, and $i$=1...11, denotes the month in which the value for a dummy is set equal to 1 e.g., $D_1$=January, $D_2$=February, ... $D_{11}$=November. While the inflation and the *m2x* series do not contain any seasonal component, the *m2* series exhibit seasonal patterns in January and Jun of each year.[90] In addition, a dummy variable *DO94* is included to account for the exogenously induced inflation that occurred in October 1994 as result of the exchange rate crises commonly referred as the Black Tuesday. The dummy variable takes a value of 1 for October 1994 and zero otherwise.[91]

### 4.3 The Model of Wiener-Granger Causality and Lag-Length Selection Criteria

While the significant lead-lag relationship between money supply and inflation in Russia has been confirmed by a number of studies,[92] not much has been revealed about cause and effect of this relationship. A common approach to detect direction of causality is to utilize the test given initially by Wiener (1956) but better known as the Granger (1969)

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[90]
$$\underset{}{m2} = \underset{(15.4)}{18.61} - \underset{(-10.15)}{0.27\,trend} - \underset{(-2.79)}{6.18D1} + \underset{(2.03)}{4.19D6}$$

($t$ statistics in parenthesis).

[91] At the beginning of October 1994, the CBR lost control over the exchange rate and with reserves running low, was unable to prevent Black Tuesday on October 11, when the ruble (R) to dollar ($) exchange rate fell by 28%, jumping from R3,000 to almost R4,000 in one day. While there have been many financial and other crises in Russia during transition, the magnitude of the Black Tuesday crises, if not taken into account, renders a simple distributed lag (DL) model of the money-price relationship given in Nikolić (2000a) to be unstable. In addition to the structural break that seemed to occur in the 1994, the failure to take account of this exogenous shock caused the true partial coefficients simultaneously to equal zero ($F$-test). A similar exogenous shock, but with a greater magnitude, took place in August 1998. It would be necessary to take this into account in a similar manner if the period after July 1998 were modelled.

[92] see Nikolić (2000a)

causality test. The Granger's test procedure is based on the premise that if predictions of variable $Y$ obtained using past values of both $Y$ and another variable $X$ are statistically superior to forecasts obtained using only past values of $Y$, than $X$ is said to "cause" (in Granger's sense) $Y$. Standard representation of the Granger variant of the causality test could be specified and implemented as follows. Let ($\pi_t$, $m_{i,t}$) represent discrete, linearly indeterministic, stationary, bivariate time series on inflation and the growth of $i^{th}$ money supply in time $t$. The Granger test, to determine the causal relationship between the inflation series ($\pi_t$ ) and the growth of money supply ($m_{i,t}$), involves estimating the following reduced-form bivariate distributed lag model of finite order:

$$\begin{bmatrix} \pi_t \\ m_{i,t} \end{bmatrix} = \begin{bmatrix} A^a(L) & B^b(L) \\ C^c(L) & D^d(L) \end{bmatrix} \begin{bmatrix} \pi_t \\ m_{i,t} \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \tag{4.2}$$

where $t = 1,\ldots,T$; $m_i = m2, m2x$; $A(L)$, $B(L)$, $C(L)$, and $D(L)$ are one-sided lag polynomials of order $a$, $b$, $c$, and $d$, respectively, and error terms, $e_1$ and $e_2$, are assumed to be uncorrelated with zero means and constant variances (i.e., they are white noise).[93]

Examination of the Granger causality between $m_i$ and $\pi$, amounts to testing following null hypothesis: $B(L) = 0$ and $C(L) = 0$. If neither can be rejected, then $m_i$ and $\pi$ are independent series. If both are rejected, then there is a "feedback" between $m_i$ and $\pi$. If the former hypothesis is rejected but the latter is not, there is unidirectional causality running from $m_i$ to $\pi$, whereas if the latter is rejected and the former is not, the reverse is true.

The tests of the hypothesis mentioned above crucially hinge on the unknown parameters $a$, $b$, $c$, and $d$, which represent lag lengths for the one-sided polynomials $A(L)$, $B(L)$, $C(L)$, and $D(L)$, respectively. Since Granger causality test seems to be sensitive to the choice of a lag for the polynomials, the choice of an approach used to determine the lag length could be crucial for the outcome of this test.

Essentially, there are two categories of alternative approaches to determine the lag length for the lag polynomials associated with dependent and independent variables. The

[93] If the assumption of mutual non-correlation of error terms $e_{1t}$ and $e_{2t}$ held, it would allow us to estimate (2) using ordinary least square (OLS) method. Should the error terms $e_{1t}$ and $e_{2t}$ prove not to be a white noise, this has to be rectified and the estimation become much more complicated and computationally demanding.

first category consists of the so-called ad hoc approaches that are non-statistical in nature and include arbitrary lag specifications and the rule-of-thumb lag lengths specifications. The most popular lag lengths of the former are 4-4 and 8-8 for the dependent and independent variable, respectively, while the latter, advocated by Geweke (1978), favours smaller lag length for the independent variable. Extending these practices we employed the lag length of 4-4, 8-8, 12-12, and 16-16 for the dependent and independent variables, respectively, when the arbitrary approach was analyzed. The corresponding lag specifications for the rule-of-thumb method were chosen to be 4-2, 8-4, 12-8, and 16-8. Undoubtedly, there could be a variety of specification and one could argue that, when dealing with a monthly data, as in our case, it may be necessary to consider longer lag lengths than those used mostly for a quarterly data. However, Nikolic (2000) showed that the average lag between variations in money supply and price level was far shorter in postcomunist Russia than in developed market economies. Hence, the choices of the lag length specifications for the ad hoc approaches are justified, if not too laborious.

The second category of approaches used to determine the optimal lag lengths for the variables in a bivariate model consists of a number of statistical criteria presented in the recent literature (Hsiao, 1981; Batten and Thornton, 1983; McMillen and Fackler, 1984; Thornton and Batten; 1985; Jones, 1989; and Cheng, 1996).[94] Amongst a variety of the statistical selection criteria, we employed two that are the most common in use: the Akaike's (1970) final prediction error (*FPE*), initially suggested by Hsiao (1981) in causality testing, and the Bayesian estimation criteria (*BEC*) of Geweke and Meese (1981).[95] These two criteria provide interesting extremes in the balance/efficiency trade-off as pointed by Thornton and Batten (1985). The former tends to favour unbiasedness over efficiency by selecting, on average, the lags that are to long in large samples. While the latter is asymptotically efficient, its downside is that it tends to select lags that are too short in finite samples. We paid a particular attention to the *FPE* criterion, which received a different evaluation by Jones (1989) to those of Hsiao (1981) and Thornton and Batten

[94] For some of these criteria see Thornton and Batten (1985) and Geweke and Meese (1981).

[95]Unlike Batten and Thornton (1983) and Jones (1989), we refrained from using the Pagano and Hartley (1981) *t*-test (PH) for lag specification, despite its computational efficiency. The PH procedure gave similar results to the *FPE* test in both of the studies mentioned above albeit with a less parsimonious lags specifications. Since a potential weaknesses of the *FPE* criterion is that it selects lag length that are too long in large samples (it's asymptotically inefficient) we saw a little point in testing criteria which was likely to suggest even longer lag lengths. Besides, even in Jones' (1989) study the PH did not outperform the *FPE*, and it performed considerably worse than the *FPE* in the Batten and Thornton (1983) study.

(1985). The crux of the matter is the question whether the *FPE* outperforms other statistical search criteria as well as the ad hoc ones.

In order to give an adequate answer to the above question it is necessary to look into the nuts and bolts of the Hsiao's method given in the Appendix. Less technically, this is a stepwise procedure based on Granger's concept of causality and the *FPE* criterion, which is employed as a practical means to identify the order of lags of each variable in a bivariate autoregressive process. According to Hsiao (1981) the great advantage of the *FPE* criterion is that it balances the risk due to the bias when a lower order is selected and the risk due to the increase of variance when a higher order is selected. In addition, this method does not require that all the variables entering the system have identical lag lengths. Thus, unlike some other methods, which impose this artificial restriction that not only may induce some lack of efficiency of the procedure, but also it may actually bias the value, the *FPE* method is free from these restrictions. Furthermore, the *FPE* procedure, in addition to being a reasonably powerful test of exogeneity (causality), also allows a finer specification of the system equations without using an arbitrary damping factor. Moreover, economically meaningful hypothesis can still be formulated and tested based on the reduced form estimates (Hsiao, 1981).

### 4.4 Empirical results

Eq A.2, or rather the subset of equations derived from the A.2, in the Appendix according to the Hsiao's procedure, were first estimated using the OLS method, albeit inclusive of the exogenous shock dummy *DO*94, seasonal dummies, $D_i$'s, where appropriate, and a linear time trend.[96] The residuals obtained using the OLS method from the regressions however, appeared to have violated the assumption of being white noise. More specifically, the Ljung-Box Q-statistics of standardized and squared residuals was utilized to check for the existence of serial correlation (or the specification of the equation) and for autoregressive conditional heteroscedasticity (ARCH), respectively. In addition, Lagrange Multiplier (LM) test for ARCH, and skewness and kurtosis in the Jarque-Bera test, were also used when an ARCH effect was suspected. Wherever an ARCH was detected in (A.3) to (A.10), these equations were re-estimated by the ARCH or the

[96] While the rationale for inclusion of the dummies DO94 and $D_i$'s is explained above, a linear time trend is included in all equations to adjust for possible non-stationary elements

generalized ARCH (GARCH) models as proposed by Engle (1982) and Bollerslev (1986), respectively. The ARCH/GARCH specifications were obtained by minimizing the Swartz Criterion (SC) of predictive accuracy.[97] The same procedure was also implemented when estimating the ad hoc specified models described above. We looked at the ARCH(1), ARCH(2), and ARCH(3) models and, as it had become a convention, at the GARCH(1,1), GARCH(1,2), GARCH(2,2) and GARCH(2,1) models. Only in a few instances were the above-mentioned models had failed to adequately model an ARCH/GARCH term, did we use a more complex ARCH/GARCH structure. The Ljung-Box Q-statistics of standardized and squared residuals, as well as the Jarque-Bera statistics finally tested the adequacy of the ARCH/GARCH models. These statistics were insignificant in all the cases we presented.[98] Hence, the lag-length selection results, obtained by the unbiased and consistent estimation of variances employing both the *FPE* and the *BEC* criteria, are given in table 2.[99]

Table 4.2 Lag Lengths Selected by the *FPE* and the *BEC*

| Dependent Variable/ Independent Variable | *FPE* | *BEC* |
|---|---|---|
| $\pi / m2$ | 10/13 | 10/1 |
| $\pi / m2x$ | 10/15 | 10/7 |
| $m2 / \pi$ | 12/2 | 12/2 |
| $m2x / \pi$ | 14/21 | 12/12 |

According to Hsiao (1981), comparison of magnitudes of pairs of *FPE*s of controlled and manipulated variables determines the direction of causality as explained in the Appendix. Nevertheless, as noted by Thornton and Batten (1985), this procedure could be interpreted as applying higher than conventional significance level and it requires the computation of *F*-statistics in order to maintain a conventional significance levels. Hence, the standard *F*-tests for Granger causality were performed on both, the statistical and the ad hoc lag-length specifications and these results are presented in table 3.

[97] See Nikolic (2000) for more details about use of (G)ARCH models.

[98] In rare cases where Q-statistics of residuals was significant despite implementation of various ARCH/GARCH specifications we saw no purpose in presenting the results of causality or the level of significance of *F*-statistics. In short, they would be unreliable.

[99] The entire set of the model selection specifications is not presented but could be obtained from the author upon a request.

Table 4.3 Granger Causality $F$-statistics for Various Lags Specified by Different Criteria

| Dependent /Independ. Variable | Arbitrary | | | | Rule-of-Thumb | | | | Statistical | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 4-4 | 8-8 | 12-12 | 16-16 | 4-2 | 8-4 | 12-8 | 16-8 | FPE | BEC |
| $\pi / m2$ | 2.67* | 2.10* | 3.75* | 6.12* | -0.91 | 3.87* | 4.97* | 7.04* | 4.37* | 6.08* |
| $\pi / m2x$ | 6.97* | 4.13* | 4.83* | 4.98* | -0.61 | 11.69* | 1.45 | 3.82* | 3.92* | 3.60* |
| $m2 / \pi$ | 8.01* | 2.97* | 1.08 | 1.05 | 3.44* | 3.30* | 1.44 | 1.26 | 3.61* | 3.61* |
| $m2x / \pi$ | 2.35 | -1.90 | 5.41* | 4.29* | 2.09 | 0.36 | 1.10 | 2.18 | 5.53* | 4.56* |

*Note*: * significant at 5% or better level.

Table 4.3 reveals that the standard $F$-test for Granger causality produced various and at times contradictory results across specifications. In particular, all of the arbitrary specifications produced results indicating causality running from both aggregates of broad money to inflation. However, commonly used specification, 4-4 and 8-8, suggested unidirectional causality for extended broad money, and bilateral causality for ruble broad money, while 12-12 and 16-16 specifications gave contrary results.

Similarly, the matrix of the rule-of-thumb specifications also gave quite contradictory results. In particular, the specification 8-4, 12-8, and 16-8 indicated causality running from ruble broad money supply to inflation but only in the 8-4 specifications was this bilateral causality. The specification 4-2, in contrast, indicated that none of the aggregates of broad money did cause inflation while inflation did cause only ruble broad money. Extended broad money Granger caused inflation only in the 8-4 and 16-8 specification. None of the rule-of-thumb specifications indicated that inflation caused extended broad money. However, in contrast to the ad hoc approaches, both statistical criteria indicated bi-directional causality between both of the monetary aggregates and inflation.[100]

Given the variety of the results of Granger causality, produced by the various specifications, a natural question arises: which of those specifications gave a correct account of Granger causality, or which criteria gave the best model specifications. One way to answer this question would be to compare all the specifications by the ordinary $F$-test. Since our objective was to evaluate the performance of the *FPE* relative to other criteria, all

[100] Despite the perceived superiority of the statistical search procedures for lag-length determination over the ad hoc ones, the former is not immune from criticism because the researcher chooses the maximum lag length arbitrarily.

of the *FPE*-selected models were compared with those selected by the ad hoc and the *BEC*. Following Thornton and Batten (1985), if the *F*-statistics for the *FPE*-selected models, that are of a higher order (*H*) than the alternative model, were significant at the conventional 5 percent significance level, the *FPE*-specified model would be favoured to the alternative one. Conversely, if *F*-statistics for the *FPE*s of lower order (*L*) than alternative were not significant, the *FPE* would be preferred model. The results of this comparison, presented in table 4, indicate that the *FPE* criterion, in our data set, outperforms the other specifications without exception.

Table 4.4 *F*-tests of the *FPE* Lag Specifications

| Dependent/ Indep. Var. | Arbitrary | | | Rule-of-thumb | | | | | Statistical |
|---|---|---|---|---|---|---|---|---|---|
| | 4-4 | 8-8 | 12-12 | 4-2 | 8-4 | 12-8 | 16-8 | 16-16 | *BEC* |
| $\pi / m2$ | 10.18* (*H*) | 14.39* (*H*) | 5.62* (*H*) | 1.28 (*L*) | 12.97* (*H*) | 9.09* (*H*) | 1.81 (*L*) | 0.54 (*L*) | 3.21* (*H*) |
| $\pi / m2x$ | 7.33* (*H*) | 8.31* (*H*) | NN | 0.64 (*L*) | 10.26* (*H*) | 4.82* (*H*) | NN | NN | 3.20* (*H*) |
| $m2 / \pi$ | NN | NN | 0.63 (*L*) | 0.86 (*L*) | 11.53* (*H*) | NN | -0.35 (*L*) | 0.43 (*L*) | - |
| $m2x / \pi$ | 22.28* (*H*) | 23.71* (*H*) | 3.68* (*H*) | NN | 22.55* (*H*) | 12.86* (*H*) | 7.42* (*H*) | NN | 5.79* (*H*) |

*Note*: NN represent non-nested models that are not tested.

A dash (-) indicates the same lag length as one chosen by the *FPE*.

* Significant at the 5% or better level.

The results presented in table 4 not only reveal the comparative superiority of the *FPE*-selected model over both the ad hoc and the *BEC*, but also have implication for the assessment of the results of the Granger causality test reported in table 3. Namely, given the results of table 4, it appears that the *FPE* criteria gave an order of the models that correctly identified Granger causality between inflation and the both aggregates of broad money supply in Russia. Therefore, as table 3 reveals, there exist feedback or bilateral causality between both ruble broad money and inflation and extended broad money and inflation in Russia.

The results presented in table 3 illustrate that the outcome of causality testing is clearly sensitive to the choice of the lag-length specifications. Thus, contrary to Jones (1989) claim, the arbitrary lag length specification of 4-4 and 8-8 that are most common in the literature, as well as the other arbitrary specification, may produce misleading results as indicated by Thornton and Batten (1985). Likewise, the rule-of-thumb methodology produced even less satisfactory results. In short, none of the ad hoc approaches produced a complete set of satisfactory results for the given sample. In contrast, both statistical criteria, the *FPE* and the *BEC*, performed very well.

To further illustrate the extent of sensitivity of Granger causality test to the choice of a lag-length specification, an extensive search of the lag space similar to that of Thornton and Batten (1985), and Jones (1989) was performed. The lag search was conducted over all possible combinations of up to fifteen lag lengths for the dependent and independent variables.[101] In line with Thornton and Batten (1985) and Jones (1989), we reported marginal significance levels for the computed *F*-statistics of Granger tests in Tables 5 and 6.[102]

[101] While an extensive search of the lag space would be a reasonably efficient procedure for a bivariate case in which the OLS estimates gave satisfactory results, it would be burdensome and computationally less efficient in the ARCH/GARCH estimations. For example, a search of the lag space with fifteen lags required about 1800 regressions in our case. Hence, extending the lag space to 21 lags if not more, as could be more appropriate for the regression of $m2x$ on $\pi$, would be very demanding computationally.

[102] The preference for the report of the significance level over *F*-statistics is guided by the fact that latter is not invariant with respect to degrees of freedom.

Table 4.5 Significance Levels for Granger Causality Tests of $\pi$ and $m2$

| $\pi$ on $m2$ | Lags of $\pi$ | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lags of $m2$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1 | 0.115 | 0.108 | 0.279 | 1.000 | 1.000 | 0.144 | 0.000* | 0.000* | 0.000* | 0.000* | 0.002* | 0.012* | 0.042* | 0.048* | 0.051 |
| 2 | 1.000 | 0.874 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.020* | 0.026* | 1.000 | 0.036* | 0.001* | 0.032* | 0.016* |
| 3 | 0.465 | 0.965 | 1.000 | 1.000 | 1.000 | 1.000 | 0.666 | 0.774 | 0.041* | 0.003* | 0.350 | 0.613 | 1.000 | 0.266 | 0.020* |
| 4 | 0.121 | 0.887 | 0.968 | 0.875 | 0.001* | 0.093 | 0.394 | 0.253 | 0.048* | 0.140 | 0.003* | 0.308 | 1.000 | 0.004* | 0.031* |
| 5 | 1.000 | 0.982 | 1.000 | 0.133 | 1.000 | 1.000 | 0.912 | 0.020* | 0.000* | 0.040* | 0.000* | 0.073 | 0.017* | 0.000* | 0.049* |
| 6 | 0.000* | 1.000 | 1.000 | 0.999 | 0.091 | 0.001* | 0.001* | 0.315 | 0.020* | 0.154 | 0.042* | 0.094 | 0.119 | 0.000* | 0.006* |
| 7 | 0.000* | 0.992 | 0.944 | 0.243 | 0.001* | 0.398 | 0.000* | 0.029* | 0.002* | 0.004* | 0.231 | 0.000* | 0.002* | 0.000* | 0.022* |
| 8 | 0.000* | 0.867 | 1.000 | 0.183 | 0.381 | 0.219 | 0.281 | 0.706 | 0.010* | 0.070 | 0.000* | 0.002* | 0.005* | 0.003* | 0.028* |
| 9 | 0.000* | 0.001* | 0.003* | 0.044* | 0.994 | 0.042* | 0.076 | 0.061 | 0.002* | 0.669 | 0.000* | 0.725 | 0.001* | 0.000* | 0.005* |
| 10 | 0.050 | 0.029* | 0.055 | 0.094 | 0.933 | 1.000 | 0.021* | 0.986 | 0.000* | 0.002* | 0.000* | 0.000* | 0.000* | 0.000* | 0.001* |
| 11 | 0.017* | 0.007* | 0.046* | 0.300 | 0.015* | 0.167 | 0.001* | 0.012* | 0.002* | 0.000* | 0.000* | 0.000* | 0.001* | 0.000* | 0.074 |
| 12 | 0.465 | 0.009* | 0.512 | 0.004* | 0.664 | 0.994 | 0.000* | 0.000* | 0.000* | 0.000* | 0.001* | 0.000* | 0.000* | 0.003* | 0.001* |
| 13 | 0.461 | 0.024* | 0.841 | 0.217 | 0.093 | 0.038* | 0.001* | 0.000* | 0.000* | 0.001* | 0.001* | 0.001* | 0.002* | 0.004* | 0.003* |
| 14 | 0.506 | 0.044* | 0.463 | 0.058 | 0.125 | 0.018* | 0.000* | 0.002* | 0.002* | 0.002* | 0.002* | 0.002* | 0.004* | 0.007* | 0.005* |
| 15 | 0.049* | 0.079 | 1.000 | 0.031* | 0.000* | 0.001* | 0.001* | 0.000* | 0.015* | 0.012* | 0.002* | 0.003* | 0.004* | 0.008* | 0.008* |

| $m2$ on $\pi$ | Lags of $m2$ | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lags of $\pi$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.180 | 1.000 | 0.194 | 0.820 | 0.917 | 0.887 | 0.914 |
| 2 | 1.000 | 0.793 | 0.161 | 0.039* | 0.055 | 0.005* | 0.012* | 0.033* | 0.037* | 0.049* | 0.100 | 0.035* | 0.052 | 0.070 | 0.056 |
| 3 | 0.172 | 0.007* | 0.172 | 0.002* | 0.055 | 1.000 | 1.000 | 0.078 | 0.087 | 0.820 | 0.320 | 0.082 | 0.116 | 0.149 | 0.124 |
| 4 | 0.000* | 0.000* | 0.002* | 0.004* | 0.111 | 1.000 | 1.000 | 0.063 | 0.139 | 0.196 | 0.785 | 0.049* | 0.076 | 0.106 | 0.086 |
| 5 | 0.808 | 0.003* | 0.013* | 0.023* | 0.184 | 0.017* | 0.027* | 0.044* | 0.229 | 1.000 | 0.346 | 0.074 | 0.074 | 0.103 | 0.076 |
| 6 | 0.002* | 0.001* | 0.001* | 0.002* | 0.028* | 0.995 | 1.000 | 0.074 | 0.308 | 0.482 | 0.290 | 0.102 | 0.098 | 0.154 | 0.131 |
| 7 | 0.006* | 0.003* | 0.006* | 0.006* | 0.038* | 0.016* | 0.013* | 0.060 | 0.262 | 0.200 | 1.000 | 0.157 | 0.153 | 0.225 | 0.188 |
| 8 | 0.010* | 0.010* | 0.029* | 0.026* | 0.106 | 0.138 | 1.000 | 0.025* | 0.053 | 0.042* | 0.333 | 0.208 | 0.224 | 0.314 | 0.271 |
| 9 | 0.002* | 0.004* | 0.013* | 0.020* | 0.181 | 1.000 | 1.000 | 0.095 | 0.087 | 0.064 | 0.062 | 0.245 | 0.076 | 0.115 | 0.159 |
| 10 | 0.021* | 0.027* | 0.042* | 0.053 | 0.258 | 0.164 | 1.000 | 0.098 | 0.077 | 0.088 | 0.123 | 0.320 | 0.116 | 0.138 | 0.211 |
| 11 | 1.000 | 0.107 | 0.095 | 0.111 | 0.374 | 1.000 | 1.000 | 0.174 | 0.146 | 0.159 | 0.179 | 0.359 | 0.161 | 0.193 | 0.289 |
| 12 | 1.000 | 0.160 | 0.076 | 0.128 | 0.392 | 0.277 | 0.294 | 0.333 | 0.309 | 0.325 | 0.346 | 0.401 | 0.226 | 0.262 | 0.376 |
| 13 | 0.978 | 0.891 | 0.055 | 0.061 | 0.189 | 0.069 | 0.081 | 0.110 | 0.144 | 0.160 | 0.178 | 0.126 | 0.140 | 0.153 | 0.265 |
| 14 | 0.999 | 0.510 | 0.101 | 0.119 | 0.246 | 0.105 | 0.120 | 0.161 | 0.207 | 0.187 | 0.202 | 0.180 | 0.200 | 0.178 | 0.310 |
| 15 | 1.000 | 1.000 | 0.140 | 0.149 | 0.215 | 0.172 | 0.178 | 0.212 | 0.262 | 0.222 | 0.244 | 0.190 | 0.210 | 0.128 | 0.165 |

*Note*: * Significant at the 5% or better level.

Table 4.6. Significance Levels for Granger Causality Tests of $\pi$ and $m2x$

| $\pi$ on $m2x$ | Lags of $\pi$ | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lags of $m2x$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1 | 0.021* | 0.021* | 0.022* | 0.023* | 0.002* | 0.001* | 0.000* | 0.023* | 1.000 | 0.528 | 1.000 | 0.658 | 0.115 | 0.899 | 1.000 |
| 2 | 0.580 | 0.614 | 1.000 | 1.000 | 0.898 | 0.089 | 0.045* | 1.000 | 1.000 | 1.000 | 0.385 | 1.000 | 1.000 | 0.473 | 0.394 |
| 3 | 0.447 | 0.306 | 0.538 | 0.001* | 0.224 | 0.012* | 0.000* | 0.000* | 0.000* | 0.023* | 0.002* | 0.163 | 0.412 | 0.879 | - |
| 4 | 0.007* | 0.027* | 0.006* | 0.025* | 0.010* | 0.000* | 0.000* | 0.000* | 0.000* | 0.028* | 0.000* | 0.072 | 0.001* | 0.145 | 0.023* |
| 5 | 0.023* | 0.085 | 0.030* | 0.019* | 0.072* | 0.053 | 0.000* | 0.000* | 0.001* | 0.290 | 0.003* | 0.970 | 0.352 | 0.095 | 0.020* |
| 6 | 0.010* | 0.000* | 0.000* | 0.007* | 0.010* | 0.010* | 0.000* | 0.000* | 0.004* | 0.025* | 0.016* | 1.000 | 0.255 | 0.224 | 0.365 |
| 7 | 0.012* | 0.430 | 0.170 | 0.326 | 0.117 | 0.152 | 0.012* | 0.039* | 0.000* | 0.002* | 0.005* | 0.007* | 0.001* | 0.001* | 0.030* |
| 8 | 0.000* | 0.563 | 0.002* | 0.077 | 0.048* | 0.072 | 0.126 | 0.060 | 0.001* | 0.010* | 0.011* | 0.205 | 0.097 | 0.104 | 0.919 |
| 9 | 0.005* | 0.067 | 0.002* | 0.023* | 0.017* | 0.003* | 0.000* | 0.014* | 0.002* | 0.021* | 0.015* | 0.288 | 0.091 | 0.308 | 0.222 |
| 10 | 0.031* | 0.414 | 0.042* | 0.221 | 0.154 | 0.155 | 0.124 | 0.025* | 0.178 | 0.051 | 0.066 | 0.438 | 0.016* | 0.130 | 0.470 |
| 11 | 0.035* | 0.083 | - | 0.082 | 0.024* | 0.303 | 0.011* | 0.004* | 0.083 | 0.082 | 0.159 | 0.035* | 0.040* | 0.434 | 0.444 |
| 12 | 0.170 | 0.157 | 0.344 | 0.042* | 0.055 | 0.011* | 0.041* | 0.025* | 0.046* | 0.012* | 0.002* | 0.002* | 0.002* | 0.004* | 0.003* |
| 13 | 0.605 | 0.414 | 0.632 | 0.286 | 0.968 | 0.003* | 0.000* | 0.053 | 0.001* | 0.020* | 0.004* | 0.004* | 0.003* | 0.006* | 0.007* |
| 14 | 0.123 | 0.572 | 0.094 | 0.533 | 0.689 | 1.000 | 0.999 | 0.298 | 0.934 | 0.037* | 0.011* | 0.009* | 0.008* | 0.011* | 0.011* |
| 15 | 0.676 | 0.103 | 0.446 | 0.002* | 0.300 | 0.001* | 0.002* | 0.002* | 0.004* | 0.006* | 0.008* | 0.006* | 0.009* | 0.015* | 0.013* |

| $m2x$ on $\pi$ | Lags of $m2x$ | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| lags of $\pi$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 1 | - | 1.000 | 0.474 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.568 | 1.000 | 1.000 | 1.000 |
| 2 | - | 0.436 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.156 | 1.000 | 0.464 | 1.000 | 0.711 | 1.000 | 1.000 | 0.529 |
| 3 | - | 0.015* | 0.340 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.661 | 1.000 | 0.535 | 1.000 | 1.000 | 1.000 |
| 4 | 1.000 | 0.273 | 1.000 | 1.000 | 1.000 | 1.000 | 0.593 | 0.854 | 0.946 | 0.800 | 1.000 | 0.603 | 1.000 | 1.000 | 0.807 |
| 5 | 1.000 | 1.000 | 0.472 | 1.000 | 1.000 | 1.000 | 0.676 | 0.907 | 0.932 | 0.582 | 0.629 | 0.322 | 1.000 | 1.000 | 1.000 |
| 6 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.928 | 0.830 | 0.696 | 0.068 | 0.428 | 1.000 | 1.000 | 1.000 |
| 7 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.052 | 1.000 | 0.603 | 0.800 | 0.136 | 0.005* | 0.162 | 1.000 | 0.571 |
| 8 | 1.000 | 0.139 | 0.153 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 0.995 | 0.793 | 0.030* | 0.054 | 0.646 | 0.749 | 0.137 |
| 9 | 0.009* | 0.299 | 1.000 | 0.019* | 0.028* | 0.048* | 0.998 | 0.231 | 0.780 | 0.119 | 0.074 | 0.378 | 0.059 | 0.978 | 0.376 |
| 10 | 0.681 | 0.620 | 1.000 | 1.000 | 0.615 | 0.162 | 1.000 | 1.000 | 1.000 | 0.032* | 0.001* | 0.022* | 0.035* | 0.382 | 0.362 |
| 11 | 0.262 | 0.530 | 0.872 | 0.935 | 0.821 | 0.160 | 0.997 | 1.000 | 1.000 | 0.012* | 0.015* | 0.007* | 0.002* | 0.013* | 0.002* |
| 12 | - | 0.001* | 0.225 | 0.919 | 0.288 | 0.151 | 0.300 | 0.187 | 0.006* | 0.007* | 0.007* | 0.002* | 0.194 | 0.004* | 0.000* |
| 13 | - | 0.004* | 0.876 | 0.463 | 0.809 | - | 0.299 | 0.845 | - | 0.013* | 0.945 | 0.265 | 0.017* | 0.032* | 0.000* |
| 14 | - | 0.420 | 0.038* | 0.339 | 0.083 | 0.000* | 0.001* | 0.004* | 0.000* | 0.001* | 0.008* | 0.003* | 0.019* | 0.012* | 0.000* |
| 15 | - | 0.000* | - | - | 0.001* | 0.000* | 0.001* | 0.004* | 0.000* | 0.000* | 0.001* | 0.001* | 0.000* | 0.001* | 0.000* |

*Note*: * Significant at the 5% or better level.

A dash (-) indicates that no ARCH/GARCH or OLS estimates give white noise residuals so that no reliable decision in respect of Granger causality could be made.

The results presented in tables 5 and 6, add further evidence to the findings revealed in table 3; i.e., that causality tests between inflation and both aggregates of money supply are heavily dependent on the lag length specification. Consequently, it is clear that use of ad hoc approaches to determine the order of lags in these tests may produce seriously misleading results as in our sample.

Finally, as the *FPE* criteria appears to be superior to the other methods of model specifications under consideration, we combined all single equations specifications obtained by the *FPE* criteria in order to identify the system. Given the existence of feedback or bilateral causality between both $m2$ and $m2x$ on one side and $\pi$ on the other, a bivariate feedback model for both of the broad money aggregates and inflation fitted the data best. Hence, for the $m2$ and $\pi$ pair we chose:

$$\begin{bmatrix} \pi_t \\ m2_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} A^{10}(L) & B^{13}(L) \\ C^2(L) & D^{12}(L) \end{bmatrix} \begin{bmatrix} \pi_t \\ m2_t \end{bmatrix} + \begin{bmatrix} D_1 \\ D_1 \end{bmatrix} + \begin{bmatrix} D_6 \\ D_6 \end{bmatrix} + \begin{bmatrix} DO94 \\ 0 \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \tag{4.3}$$

where the $c_i$ are constants, $A(L)$, $B(L)$, $C(L)$, and $D(L)$ are one-sided lag polynomials of order 10, 13, 2, and 12, respectively; ($D_i$) and ($DO94$) are seasonal and October 1994 dummies respectively, and the $e_i$ are white noise error terms described above. Subsequently, for the $m2x$ and $\pi$ pair we chose:

$$\begin{bmatrix} \pi_t \\ m2x_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} A^{10}(L) & B^{15}(L) \\ C^{21}(L) & D^{14}(L) \end{bmatrix} \begin{bmatrix} \pi_t \\ m2x_t \end{bmatrix} + \begin{bmatrix} DO94 \\ 0 \end{bmatrix} + \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix} \tag{4.4}$$

### 4.5 Policy Considerations

We noted above that, for a variable to be useful as a policy target, unidirectional causation from it to a goal variable was one of the necessary conditions. Hence, the finding of the feedback or bilateral causality between monetary aggregate *m2* and inflation severely limits ability of the former to be an effective policy target for the latter. The existence of such a relationship means that, movements in the target variable may reflect the combined influence of policy actions and movements in the goal variable not directly attributable to desired policy changes. In other words, if the target variable both causes and is caused by the goal variable, then it does not provide an unambiguous signal of where actions are headed. The counter argument may be that the authorities may be able to control the money growth rate, but reacted to past inflation by partially accommodating it. It may indeed be the case that feedback causality was the result of accommodation of inflation. Does this mean that the strict control of the money growth rate would ensure stabilisation of inflation in Russian economy at the beginning of transition? Had velocity of money been constant and the institutional infrastructure of a competitive market economy in place the answer to the previous question would have possibly been positive. However, as documented above, and shown in Fig. 2.1, the velocity was far from constant and we know that the institutional infrastructure of a competitive market economy was not in place, at least not during first half of 1990s in Russia. In addition, it was utterly unrealistic to expect from Russia to have a strict monetary policy and a balanced budget amidst transformational recession when no domestic borrowing was possible, or envisaged, and the majority of international loans were not forthcoming. Lack of financial discipline in this period meant that monetary tightening resulted in considerable increase in barter, widespread use of money surrogates and prevalence of all sorts of arrears. Widespread dollarisation signified diminishing role of the ruble as a unit of account. In such an economic environment, had the government not been a large agent paying and demanding payments in rubles, the role of the ruble as a medium of exchange would have been endangered.

Yet, notwithstanding this evidence, monetary authorities in Russia adhered to monetary targeting for a considerable length of time. More specifically, in the 'Guidelines on the monetary policy of the CBR' presented to the Russian parliament early in 1992, the Gaidar government opted to target quarterly growth rates of $M2$. A failure to comply with its agreed targets, exceeding them by far, unsurprisingly resulted in a high inflation rate during entire 1992 and 1993. One of the reasons for the failure was the total disorder of monetary data, which made such targets unreliable. In 1993, targets for credit to commercial banks, to the budget, and to other former Soviet republics were set. In addition, floor levels for net international reserves, gross reserves, and ceilings for the CBR's net domestic assets (NDA) and the net credit to the enlarged government, i.e., credit targets, were set (Buch, 1998). The additional target levels for $M2$ and monetary base followed these practices in 1994. Under strong auspices and guidance of the IMF, Russian monetary authorities continued carrying out their approach employed in 1994 also in 1995. $M3$ was used not only as the main intermediate target for monetary policy but also for calculating the targets for the monetary base and the NDA of the CBR (Bofinger *et al.*, 1997).[103]

[103] The same approach was adopted for two other members of the CIS-3, Ukraine and Kazakhstan.

In July 1995, Russian authorities officially announced a corridor for the ruble/dollar exchange rate, which was adjusted in the following year and finally modified into a sort of crawling peg. This action, on the part of policymakers, did not exclude the practice of monetary targeting.[104] However, according to Bofinger *et al.* (1997) the strong overshooting of the monetary targets could not allow this stabilization program to be classified as a money-based stabilization, but rather as the exchange rate based stabilization, which turned out to be successful in short to medium term.

The poor results of stabilization efforts prior to 1995, gave ammunition to critics of the design and implementation of the IMF-supported policies. The suitability of the orthodox, money-based stabilization program was thus brought under spotlights. Economic literature suggest, that a few money-based stabilizations implemented in the high-inflation countries, like Chile in 1974-1975, and Argentina and Brazil in early 1990, could not be cheering experience to be recommended to transition economies. The sluggishness with which money-based programs reduce inflation and their adverse effects on output and employment make them unsuitable for use in the high-inflation countries. In contrast to exchange rate based stabilizations, the recessionary effects of money-based programs tend to be immediate. This is mainly due to the short-term downward rigidity in prices and wages and the lack of credibility in the government resoluteness to stick to targets. The next serious reservation is related to the essential pre-condition for money-based stabilization – stable velocity of money. Given the severe limitations of monetary targeting in the OECD countries, it was observed that money-based approaches were unlikely to be suitable for short-term stabilization in transition economies where a stable demand for money was not observed, at least in the early years of transition (Bofinger *et al*, 1997).[105] Furthermore, it was argued that monetary targets carried the danger of Dornbusch-style exchange rate overshooting (Fisher, 1986). Moreover, even if velocity could be forecasted perfectly, it

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[104] On 22.2.96 the CBR and the government set out a medium-term strategy for economic policy agreed with the IMF, which provides Russia with an Extended Fund Facility (EFF) credit of $10.2bn. The EFF, designed to operate for a longer period of time than the stand-by facility granted in the previous year, was going to span for 3-year period. In order to insure appropriate implementation of the programme by the Russian authorities the IMF was to monitor the implementation of the targets specified in the program on a monthly, rather than a quarterly basis. These targets included ceilings on the NDA, limits on monetary authorities' net credit to the federal and general governments, as well as floors on net and gross international reserves. The latter were to reach $19.7 bn. by the end of 1996 (RET, 1996). By the end of first quarter of 1996 all of the indicative targets on the monetary programme were met.

[105] Bofinger *et al.* argued that, while the Bundesbank uses monetary targeting as a medium-term policy guideline, the IMF applies this concept for short-term stabilisation purposes. Furthermore, they argued that this practice was inconsistent with the monetarist paradigm, which opposes all sort of fine tuning because of the famous "long and variable lags" in monetary policy.

would be needed to forecast both, real output and prices, to set a sensible target for monetary aggregate. This task could be particularly difficult at a time of considerable doubt about the real output and the prices, as during early transition (Begg, 1997). Literature advocates that in the face of an unstable money demand, an exchange rate anchor may not only both signal and help secure the end of an inflationary spiral, thereby enhancing confidence and helping in the re-monetisation, but also it may induce a greater commitment to the fiscal adjustment which was desperately lacking in Russia.[106]

With a benefit of hindsight, it emerged that despite its shortcomings, exchange rate peg, with occasional credible realignments, might have been earlier introduced as an arguably better instrument for stabilizing Russian economy. Alternatively, money targeting might have been used as a medium-term policy guideline as practiced by Bundesbank and Swiss National Bank rather than for short term stabilisation purposes. Nonetheless, such policy prescription could not spare the IMF team and the Prime Minister Gaidar of embarrassment related to the vast underestimation of corrective inflation in January 1992. The inflation was assumed to be 100% against the actual 245%, and as a consequence dented government credibility for Q1, 1992 (Gomulka, 1995). It is also not clear to what extent that policy would absorb the other policy errors of the IMF. Among these are an initial support for a common currency and monetary union of most of the Former Soviet Union, and stubborn insistence on macroeconomic policies and stabilization, largely neglecting reforms in liberalization, privatization, and institutional change (Gomulka, 1995), not to mention economic growth. What's more, it is unclear what implication such policy might have had on fiscal responsibility which is as important as the choice of aggregate targets, if not more.

On the other hand, it was argued (Begg, 1997) that money-based stabilizations performed surprisingly well in the group of transition economies including Albania, Slovenia, Latvia, and Lithuania. Along the same lines Buch (1998) argued that the experience with monetary targeting was not entirely disappointing in Russia. As argument went, it helped the CBR to reduce growth in domestic assets, particularly lending to government. In addition, despite the evident instability of demand for money across majority of transition countries over time (Begg, 1997), Buch (1998) found that the long

[106] The lack of political consensus to undertake large fiscal adjustment was revealed in the failure to take necessary budget measures as well as to restrict credit to enterprises and sectors as stipulated by the several IMF-supported programs.

run money demand in Russia remained relatively stable, although short run fluctuations were substantial. Subsequently, Buch (1998) argued that the CBR ought to aim at moving to a monetary target in the medium-term.

In should be noted that, when monetary targeting was applied in Russia, a prediction for a demand for money could hardly be based on solid foundations. This is not only related to the great uncertainty associated with the years after the price liberalization of January 1992, but also to the lack of meaningful time series of the economic aggregates measured in the new policy regime. For the same reasons, policymakers could not scrutinize suitability of any of the monetary aggregates along the criteria suggested above, except using a very short time series bound to produce unreliable and susceptible results. In addition, in the pursuit of multiple nominal anchors, as it was the case in Russia, failure of one should not prejudice the entire program. Moreover, for any nominal anchor, fiscal (ir)responsibility mattered even more, as evidenced by the financial crises of August 1998.

The merits of the arguments for and against monetary targeting indubitably extend to economies other than transition ones. Our analysis nevertheless, leads to the conclusion that, given the existence of bilateral or feedback causality between both aggregates of the broad money supply and inflation, use of the former as the intermediate targets to control the latter, had severe limitation in postcommunist Russia. These empirical results signify the accommodating character of Russian monetary policy, as indeed was the case with the Visegrad countries in the early years of transition (Rostowski and Nikolić, 1998). Had the Russian government not been accommodating inflation in the early years of transition, in the environment of ill financial discipline and underdeveloped competitive economic infrastructure it would have risked endangering the role of the ruble as medium of exchange. Bofinger *et al.* (1997) showed that, questionable stability of the demand for money, together with a use of monetary targeting for short-term stabilization purposes instead of a medium-term policy guideline as practiced by Bundesbank and Swiss National Bank, was "completely misconceived" concept for transition countries. As argument went, money based stabilization that was developed for stable economies, would result in the liquidity crunch (Calvo and Vegh, 1992) and consequent high interest rate, which would adversely affect the output. In light of these critiques, the continuation of quantitative targeting of money stock as the main intermediate target for monetary policy, applied during transition in Russia by the monetary authorities under the strong influence of the IMF, does seem to be questionable policy prescription.[107]

Having found that monetary aggregates were not exogenous or causally prior to inflation in Russia as well as unstable velocity of money, it would be somewhat redundant to conduct the analysis of controllability of these two aggregates of the broad money supply. Even so, it may be worth mentioning that the CBR may have had difficulties in controlling broad money supply even if the broad money supply happened to be prior to the goal variable and with no feedbacks. More specifically, since changes in broad money result from the cumulative effects of changes in the monetary base and in the money multiplier, the latter may cause the CBR to face control and information problems (Buch, 1998). The former emerges as a result of inability to predict accurately the changes in the portfolio structure of households as well as the excess reserves of commercial banks. The latter arises because the CBR, or any other central bank for that matter, observes the behaviour of money stock with a time lag.

## 4.6 Conclusion

After assessment of various criteria for the optimal choice of the lag length in causality testing, the Akaike's (1969) *FPE* criterion seems to outperform both the ad hoc and the statistical criteria under consideration. In addition, the results indicate that arbitrary lag length specifications, including the most common 4-4 and 8-8 ones, may give seriously misleading results in causality testing. That, in turn, may have severe consequences for economic policy, particularly in cases where some kind of intermediate targeting is exercised.

The correct identification of the direction of causality between broad money and inflation in postcommunist Russia gave us an opportunity to assess appropriateness of monetary policy in this transition economy. An intermediate target in this sense is appropriate if it reasonably determines a goal variable, if it is "exogenous" or causally prior to the goal of policy actions, and if it is controllable by policymakers. Assuming the first prerequisite of stable relationship between a target (ruble broad or extended broad money supply) and a goal variable (inflation) is fulfilled, as claimed in the recent literature, this

[107] The same conclusion applies to Ukraine and Kazakhstan.

study clearly demonstrates that neither of the targets is exogenous in the case of Russia. In other words, the existence of feedback or bilateral causality between inflation and both aggregates of broad money diminishes their suitability for monetary targeting. This is because none of them can provide an unambiguous signal of where policy actions are headed. As a result, these findings make redundant the testing for controllability of the monetary aggregates aforementioned.

In light of these findings, it appears that use of monetary targeting for short-term stabilization purposes applied by the Russian monetary authorities under strong auspices of the IMF, at least before the second half of 1995, might have not been the wisest policy prescription.

Finally, as it has become almost customary for Russian annalists to express the reservation in regard to the Russian statistics, we follow the suit. In addition to the conceptual problems related to the change from socialist to a market economy, we had at our disposal only relatively limited number of observations. Moreover, the period over which tests were conducted was characterized by large fall in economic activity, unprecedented transformation of economic system and socio-political institutions, the new regime of economic policy, and the advances in financial innovations. In such economic environment all the results and conclusions have to be treated with the due caution.

# CHAPTER 5

## The Role of International Financial Institutions in Stabilising Russian Economy[108]

### 5.1. Introduction

Between the end of Czarist Russia in 1917 and early 1950s, about one third of the world population in various ways made transition from market economy to central planning. In the late 1980s, a period of the final demise of Soviet empire, a leading and the most resourceful member of this group, set in motion a reverse process for most of the former socialist countries: transition from planned to market economy. A very long legacy of central planning made assistance of international financial institution to transition economies very much sought-after. This assistance was anticipated to be both financial and consultative.

Having had a considerable experience with structural reforms in Latin America, the Bretton Wood institutions, guardians of international financial system, the World Bank and the International Monetary Fund IMF, were the obvious choice for assistance to transition economies in their endeavour. These two institutions, particularly the IMF, had been involved with unequal extent and a various degree of success in Central and East European (CEE) transition economies, including Russian Federation for the most part of transition process. Given the considerable pain and protraction of Russian transition efforts, many issues related to the role of the IMF in Russia remain controversial. This chapter analysis the role of the IMF in Russia within global financial architecture, and particularly in the context of transition. It is often claimed that, the IMF, as a main guide and a coordinator of the Western assistance to Russia, has performed less than optimally in Russia (Sachs, 1997; LaRouche, 1999; Soros, 2000; Sanders, 1998, among others). IMF's positive effects of provider of credibility to this major transition economy in 1990s were, in general, annulled by the lack, not so much of pledges, but of sufficient lending disbursement at critical times

[108] I am indebted to Dr. Tomasz Mickiewicz for the useful comments on the earlier versions of this paper. Responsibility for any remaining errors rests with the author.

for a successful transition, particularly at the beginning of its involvement. In addition, the shortcomings of the IMF guided stabilisation programs in the first few years of transition (see Chapters 2 and 4), were coupled with the consistent disregard for institutional building (Kolodko, 1999), not to mention disrespect for equitable growth of Russian economy. Furthermore, as documented in section 7, the IMF made a number of policy errors, which have contributed to the delay of macro stabilisation of the Russian economy.

The reminder of this chapter is organized as follows. Sections 2 and 3 discuss briefly the role of the IMF in the present global financial architecture and the Washington consensus, respectively. Section 4 analyses the general policy consideration of the IMF involvement in Russia, while section 5 outlines the quantitative indicators of capital flows in European transition economies and Russia. Section 6 is devoted to the common criticism of the IMF programs while section 7 outlines specific policy consideration of the IMF involvement in postcommunist Russia. Section 8 elaborates the reason for a developing country to seek the IMF assistance while section 9 concludes with the summary of the findings.

## 5.2 IMF in the Present Global Financial Architecture

The Bretton Woods institutions, the World Bank and particularly the IMF have been the corner stones of the global financial system for more than five decades. During this time the results of the Bank/ Fund involvement in various stabilisation experiences has been mixed. The Bank has responded to the financial crises with recommendations to strengthen policy regimes and financial support. Although the Bank is not intended to act as a lender of last resort and is not primarily designed to fight crises, its participation has been required because of the important structural origins of the crises and the enormous impact the crises has had on income distribution and poverty.

Having had macro-economic stability as its chief aim, the IMF had a leading role in creation and execution of these programs. Over time it became possible to identify the main characteristic of these programs. Despite differences related to country-specific characteristic, most IMF's programs have three common but complement elements: (i) securing sustainable external financing; (ii) adoption of demand restraining measures - especially in the early stages of a program; and (iii) implementation of structural reforms.

The availability of external financing determines the magnitude and pace of the necessary adjustment process. At the outset of the program a country that experiences balance of payment difficulties typically can borrow only a meagre funds. IMF guidelines require that the country does not show an ex ante external financing gap, that it remain current in its debt service commitments, and that it eliminates external debt arrears it may have accumulated prior to program approval (Mussa and Savastano, 1999).

Demand restraining measures, typically understood as tightening monetary and fiscal policies, are best known but controversial elements of a typical Fund program. The intention of the architects of such programs is to bring aggregate demand in line with the prospective output and available external financing and, thus, with a sustainable current account. In order to facilitate external adjustment, program creators may, in addition, opt for the alteration of the nominal exchange rate. In recent times, the IMF tends to stress tightening of monetary rather than fiscal policy in countries with weak financial systems when investors loose their confidence. The aim is to prevent currency crises, but the IMF record in this area is not impressive.

The endeavour in a typical program to alleviate structural and institutional rigidities is aimed to facilitate an efficient allocation of resources and in doing so to smooth the progress of economic growth. Structural reform may include changes to a variety of activities and vary from a country to country. Typically, the key structural priorities for transition economies are privatisation and building of market institutions.

### 5.3 Washington Consensus for Transition Economies

The IMF involvement in steering former planned economies of Central and East Europe to market economy was biggest and unprecedented challenge of its existence. The IMF took the lead in assistance efforts of Western donor organisations and countries to transition economies. The starting point for the policy advice to these countries was the so-called Washington Consensus, a body comprised of the US Treasury, the IMF, and the World Bank. The consensus was the product of the Latin America's structural crises in the 1980s, and operated under following slogan: 'liberalise and privatise as quickly as possible, and be tough in fiscal and monetary matters'. Restructuring would follow in the later phase. Since the starting assumption was that transition economies were in macroeconomic disequilibrium, much like Latin American economies, the stabilisation was the priority.

Demand rather than supply side management was the preferred order of the day. External and internal liberalisation coupled with privatisation and stabilisations were expected to transform transition economies into fully-fledged market economies.

The Washington consensus motto was to a large extent promoted in Russia via the IMF guided reforms. The main components of the Russian reform included: a fast price liberalisation, the liberalisation of the foreign exchange market and the convertibility of the ruble, a considerable foreign trade liberalisation, macroeconomic stability, privatisation and, to a lesser extent, other systemic, structural, and institutional reforms. Safety nets and external assistance were additional, supportive features (Gomulka, 1995). The discussion about reforms usually centres on the issues of rapid or shock versa gradual pace of reforms or the gradation of these two. Since the chief concern of the IMF has traditionally been macroeconomic stability in the short and medium term, we concentrate on this issue. Subsequently, the results of the macro-stabilisation efforts would be a way of judging the degree of the IMF's success in Russia by its own criteria.

### 5.4 General Policy Consideration of the IMF Involvement in Russia

The role of the IMF in developing economies has been scrutinised particularly by the structuralist theoreticians during seventies and eighties (Taylor, 1988 among others). Inevitably, the IMF role in the Russian transition to market economy received a particular attention in the wake of financial crisis of August 1998. These articles, usually critical for their own ends, distinguish between structural deficiencies of the IMF within the global financial architecture (Soros, 2000) and the IMF's specific policy mistakes made in Russia (Sachs, 1997, among others).

The IMF involvement in Russia began after some experimentation with the early reformers in early 1990s. The Fund, together with the Russian government, devised a stabilisation plan for the biggest and most important transition economy. The first official Fund-supported programme for Russia was unveiled in June 1992, the same month the country formally rejoined the Bretton Wood institutions. Half-hearted stabilisation efforts were already enacted since autumn 1991 but with poor results. In this period the IMF position in general was that (i) the Soviet ruble should continue to be common currency for the successor states of the Soviet Union, (ii) Russia should have balanced budget deficit, and (iii) since inflation was viewed as a pure monetary phenomenon, money supply should be kept under tight control. Various monetary targets were imposed and inflation rate was supposed to decline below 5 percent per month. Conspicuously, in stabilisation efforts in the first few years neither exchange rate nor wage rate target served as a nominal anchor. Hence, orthodox money based stabilisation strategy was chosen by the IMF for Russia. The poor results of the June 1992 Fund-supported stabilisation led to another programme in June 1993. Since the latter had a similar fate as the former, it was succeeded by the more ambitious "March 1994 program". Annual inflation rate of 1526.0 percent in 1992 preceded 875.0, and 311.4 percent in the following two years (EBRD, 1998) giving little credit to each of these stabilisation efforts, even though inflation trend was downwards. In addition, as elaborated in Chapter 2, on 'Black Tuesday' on 11 October 1994, Russia suffered the first full-fledged financial crises in post-communist times. Consequently, it was clear that stabilisation doctrine had to take a new shape. After thorough preparation, the new, exchange rate based stabilisation programme, with heterodox elements, was finally implemented in June 1995. This programme was relatively successful but only in the short to medium run.[109] Macroeconomic stability is always fragile in transforming economies like the Russian Federation in which the fiscal deficit has not been brought under control and has averaged close to 8 percent per annum up to 1998 (Nikolić, 2000a). The dire position of government finances and the economy as a whole was undermined further by the other internal and external factors (see Chapter 3). The most prevalent among the former were macroeconomic and structural weaknesses, particularly over-dependence on short term capital inflows, while the latter were dominated by the fall of oil and other commodity prices and the fall in confidence on the part of the international capital investors to invest in trouble ridden countries like Russia. The failure of the policymakers to address these issues in the relatively favourable investment climate of 1997 led Russia, in August 1998, into the worst financial crises of its transition period and contributed to the global financial turbulence. The ruble was effectively devalued and left floating while the government defaulted on its own maturing short-term securities - Gosudarstvennye Kratkosrochnye Obligatsii (GKO).[110]

[109] The summer 1995 stabilisation programme is described elsewhere i.g., Bofinger et al (1997) and Nikolić (2000a).

[110] In 1998, the official exchange rate went from R5,96/$ to R20,65/$, a depreciation of 246 per cent. From August 1998 to end-March 1999, the ruble has depreciated 287 per cent, from R6,24/$ to R24,16/$. For details see Nikolić (2000a).

Failure to regain macro-economic stability during the first years after liberalisation attracted sharp criticism of the IMF from various quarters. This is not to say that the successive Russian governments are immune of criticism. Their chief fault lies in the chronic refusal to reform. Yet, reluctance of the G7 to get involved in reforms and provide financial assistance to Russia when most needed is equally to blame. Moreover, a snail pace of the World Bank involvement also contributed to failure. Even so, both, the Russian government and the IMF, were accused of squandering one after another opportunity to stabilise Russia with disastrous consequences for the welfare of the Russian people. Critics charged that these two, of which the IMF was a typical representative of the West, have never missed opportunity to miss opportunity in Russia (Sachs, 1997). During this time, a common understanding between the West and the Russian government, via the IMF, was maintained. The West would pretend to aid the Russians while they would pretend to stabilise (Granvile, 1995). Likewise, IMF promised loans and Russian government promised reforms. This turned out to be a pseudo lending for pseudo reforms.

The end result of Russian transformation endeavour in 1990s may well conform to the criticism of the IMF designed programs. Although there are doubts about its accuracy, between 1992 and 1995, Russian official statistics recorded a fall of GDP by 42 percent and a fall of industrial production by 46 percent - far worse than the contraction of the U.S. economy during the Great Depression. Critics points out that, the basic results of the IMF prescriptions for the decontrol of prices, radical economic and financial liberalization, and indiscriminate opening of markets to imported products, has been to transform Russia into a raw materials producer, rather than an agro-industrial country (LaRouche, 1999). Soros (2000) argues that the IMF has not been in Russia as having goal in economic development but merely as bill collectors for the world financial community. The critics further charges (Sanders, 1998; Soros, 2000) that, much of the IMF loans has gone to bail out international creditors, creating what is now recognised as moral hazard. The rest has mainly gone to corrupt government officials, bureaucrats, and connected businessmen.

The effect of the Russian economic policy guided by the IMF has been devastating on the Russian people. Between 1991 (time of Soviet Union collapse) and 1995, real income plummeted 40 percent. A quarter of all Russians were living below the subsistence level. Nearly one-third lived below the poverty level. Three-quarters barely survived on an average income of $100 per month. The average life expectancy for men has declined by seven years, to 59, since 1990. One-quarter of Russia's labour force receives its wages late, in kind, or not at all (Sanders, 1998).

Finally, the last strand of criticism ought to be directed at the political economy of the IMF involvement in Russia. Yet, literature is not very forthcoming with this issue. More specifically, given a large gap between promised and delivered funds, as well as timing of some deliveries, one cannot help thinking that both the IMF and the United States Treasury, which calls the tunes at the IMF, were used to spoon-fed Russia to the point of no return. No more, no less. Throughout transition period Russian reformers received just enough aid and just at the right time to remain in power and insure that Russia passes the benchmark beyond which would be highly unlikely to return to the central planning and autarky. A recent analysis (Thacker, 1999) confirmed that, contrary to expectations that the IMF has become less politicised since the end of the cold war, the influence of politics has actually increased since 1990. Thacker (1999) claims that political realignment toward the United States, the largest power in the IMF, increases a country's probability of receiving an IMF loan. The study concluded that the behaviour of multilateral organizations is still driven by the political interests of their more powerful member states.

## 5.5 Quantitative Indicators of Capital Flows and the IMF Involvement in the European Transition Economies and the Russian Federation

Capital flows in Russia from 1989 to 1993 were shaped by Western governments' determination to make the transition "stick", coupled with a wait-and-see approach by private sources of funds. In addition to the financing provided by the IMF and the World Bank, bilateral credits were extended to Russia mostly from seven major industrial countries. Moreover, official creditors, under the auspices of the Paris Club, and debt deferrals by commercial bank creditors offered a comprehensive debt relief package for Russia, but only in late 1990s. When economic performance improved and the transition progressed, private capital began to enter the market, first tentatively, then with great speed. Hence the sequence was as follows: official financing, FDI, non-guaranteed bank loans, dedicated equity funds, and lastly international bond issues and direct local stock and money market investments (EBRD, 1998).

Despite the fact that by 1993, virtually all of the East European economies and Russian Federation were IMF members, overall they received smaller and declining share of financial resources relative to the developing countries in the first quinquennium of the 1990s (UN/ECE, 2000). Although many transition economies attracted capital inflows[111] of the order of 5 per cent of GDP in line with developing economies between 1990 and 1998, a significant number including Russia failed to do so (UN/ECE, 2000). In fact, Fig. 1 demonstrates that despite substantial volatility, net capital inflows, including "errors and omissions", were negative in Russia between 1993 and 1998.[112] Table 5.1 demonstrates the size of the Russian net capital flows relative to other east European transition economies.

[111] Definition of capital inflow throughout this article refers to the acquisition of domestic assets by non-residents (plus grants). Sales of domestic assets are defined as a negative capital inflow. Thus the term net capital inflow denotes acquisitions minus sales of domestic assets by non-residents. Conversely, capital outflow refers to the acquisition of foreign assets by residents. Sales of foreign assets are defined as a negative capital outflow. Thus the term net capital outflow denotes acquisitions minus sales of foreign assets by residents.

[112] "Errors and omissions" stands for unrecorded capital flows, mainly capital flights.

Table 5.1 Net Capital Flows into Eastern European Transition economies, by Type and Flow (1993-1998)

| | Trade Flows 1993-98 | | | Private Flows (per GDP)[a] | |
|---|---|---|---|---|---|
| | US $ (billions) | Per capita | Per GDP[a] | Total | Long-term |
| Albania | 0.9 | 298 | 111 | 26 | 39 |
| Bosnia and Herzegovina[c] | 3.8 | 1082 | | | |
| Bulgaria | 2.5 | 292 | 62 | 47 | -1 |
| Croatia | 7.6 | 1686 | 250 | 159 | 137 |
| Czech Republic | 22.7 | 2208 | 169 | 154 | 112 |
| Hungary | 20.5 | 2017 | 204 | 207 | 160 |
| Poland | 32.4 | 837 | 112 | 80 | 61 |
| Romania | 12.4 | 550 | 87 | 44 | 42 |
| Slovakia | 8.3 | 1547 | 163 | 148 | 73 |
| Slovenia | 2.2 | 1094 | 78 | 108 | 108 |
| FYR Macedonia | 1.5 | 748 | 175 | 20 | 5 |
| Estonia | 2.4 | 1646 | 218 | 131 | 100 |
| Latvia | 1.5 | 595 | 106 | 109 | 103 |
| Lituania | 5.1 | 1389 | 223 | 63 | 55 |
| Armenia | 1.7 | 473 | 229 | 14 | 12 |
| Azerbeijan | 4 | 528 | 256 | 99 | 99 |
| Belarus | 3.8 | 366 | 62 | 14 | 10 |
| Georgia | 1.8 | 348 | 105 | 6 | 6 |
| Kazakhstan | 6.1 | 372 | 77 | 76 | 71 |
| Kyrgyzstan | 1.5 | 325 | 141 | 26 | 23 |
| Republic Of Moldova | 1.1 | 252 | 113 | 43 | 40 |
| Russian Federation | -40.8 | -277 | -40 | 21 | 17 |
| Tajikistan | 0.8 | 129 | 136 | 29 | 23 |
| Turkmenistan | 1.7 | 392 | 148 | 156 | 110 |
| Ukraine | 8 | 156 | 47 | 23 | 17 |
| Uzbekistan | 2.9 | 124 | 59 | 39 | 30 |
| Total Above[b] | 91.9 | 231 | 39 | 56 | 43 |
| Russian Federation[d] | 2.6 | 18 | 3 | 21 | 17 |

Source: UN/ECE, 2000 No. 1, pp. 149.

*Note*: Total flows are the sum of the capital and financial accounts and errors and omissions as reported in the national balance of payments statistics. Total private flows include FDI, long-term private guaranteed and non-guaranteed debt, short-term debt and portfolio equity flows.

[a] Per $100 GDP in 1997. These are Purchasing Power Parity (PPP) estimates of GDP

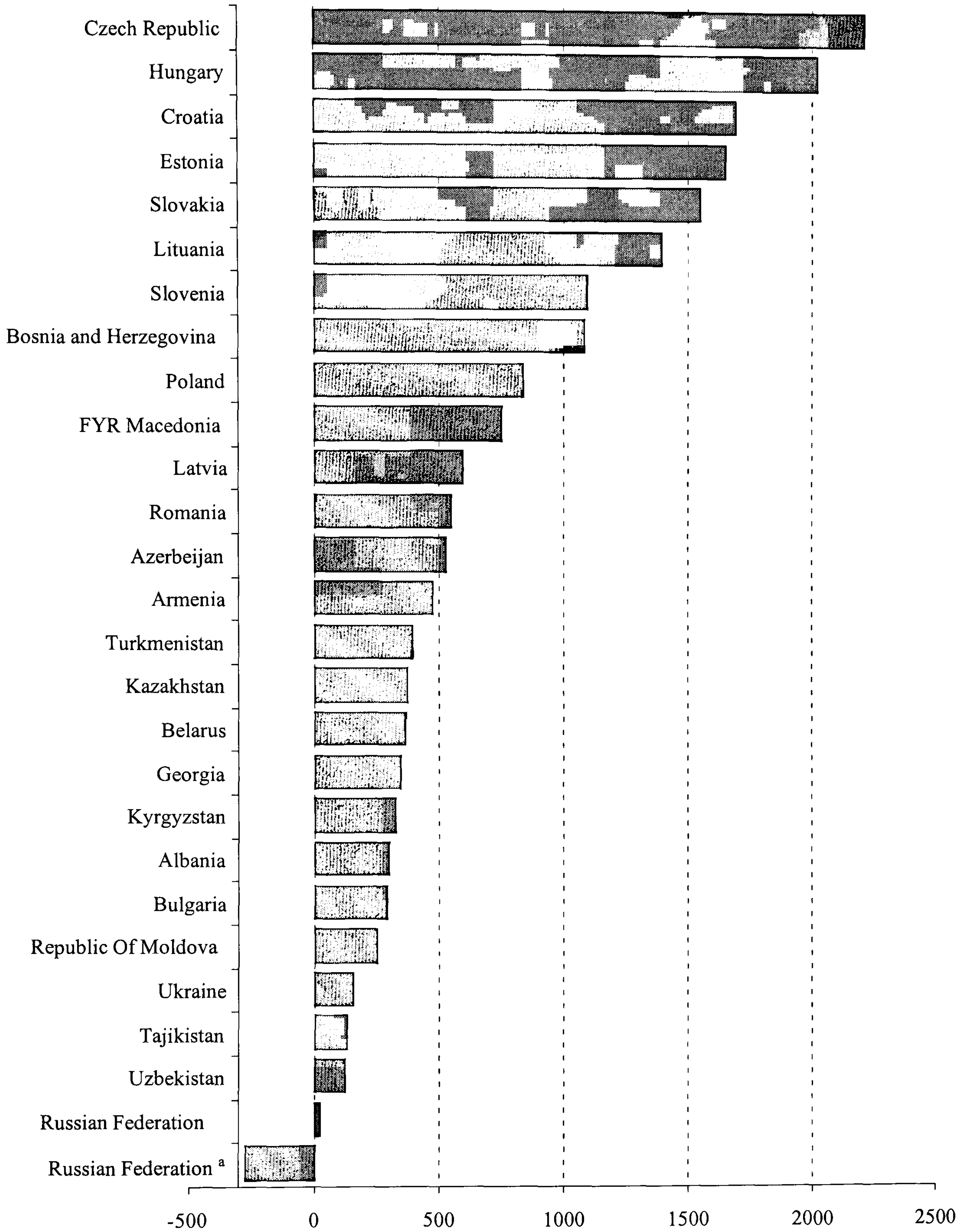
[b] Excluding Bosnia and Herzegovina

[c] 1994-1998

[d] Excluding errors and omissions from total flows

The variation in the size of capital flows among transition economies reflects their degree of economic reforms. In effect, an access to official funds is often conditional on the implementation of structural reforms and sound macroeconomic policies. Table 5.1 shows that most of the foreign capital (about 60 per cent) has been attracted by the early reforming countries – the Czech Republic, Hungary and Poland. In contrast, although the exact size of the volatile Russia's capital flows is uncertain, Fig. 5.1 indicates that inflow of capital per capita has been negligible while outflows were substantial. While the former represents reported financial inflows, the latter is calculated as the sum of recorded flows and "errors and omissions". This latter item is generally considered to include unrecorded capital flows, which is a synonym for capital flight (Table. 5.9). Russian total capital outflows, including unrecorded capital, averaged about 3 per cent of GDP in 1993-1998 period (UN/ECE, 2000). Such a large outflow of capital has been made possible by a large current account surplus and foreign borrowing.

Fig. 5.1 Capital Flows into Transition Economies (1993-1998) US $ Per Capita




Source: UN/ECE, 2000 (See Table 5.1).

*Note*: [a] Including errors and omissions

The increase in the growth of capital inflows into transition economies during 1990s has been associated with the change in their composition (Table 5.2). While the five leading

Central European Transition Economies (CETE-5)[113] have steadily decreased official financing and even repaid the IMF debts by 1996, Russian Federation increased the size of official funds after 1994. These official funds were mostly comprised of IMF credits and grant aid, and accounted for the most of official financial inflows into transition economies. A large share of the official capital flows were on account of German transfers to the former Soviet Union, as part of the German unification agreement. As the transition got underway private flows (FDI, long-term debt and short term debt) began to dominate capital market. An important proportion of private inflows has taken the form of so-called non-debt creating inflows, notably FDI. On average, the share of FDI in total net inflows was higher in transition economies than in developing countries though this does not apply to Russia.[114]

Table 5.2 Net Capital Flows into the Five Central European Transition Economies (CETE-5) and Russia, by type of finance, 1993-98 (per cent of GDP)

| | CETE-5 | | Russian Federation | |
|---|---|---|---|---|
| | 1993-95 | 1996-98 | 1993-95 | 1996-98 |
| Capital transfers[a] | 1.8 | 0.1 | 0.2 | -0.1 |
| FDI | 2.3 | 2.6 | 0.4 | 0.7 |
| Long-term debt | 0.9 | 0.3 | -0.7 | -0.3 |
| External bonds | 1.4 | 0.4 | -0.1 | 1.5 |
| IMF | -0.5 | -0.1 | 1.1 | 0.9 |
| Short -term funds | 1.3 | 2.3 | -2 | -2.4 |
| Portfolio investment[b] | 0.6 | 0.6 | -0.2 | 4 |
| Short -term flows | 0.3 | 0.9 | 0.1 | -3.9 |
| Errors and omissions | 0.4 | 0.8 | -1.9 | -2.5 |
| Total net flows | 6.2 | 5.2 | -2.1 | -2.1 |
| Total flows (US$ bn) | 40.5 | 45.3 | -16.5 | -24.3 |

Source: UN/ECE, 2000 No. 1, pp. 151.

*Note:* [a] Includes debt write-offs under debt restructuring agreements, especially important for Poland during 1993-1995.

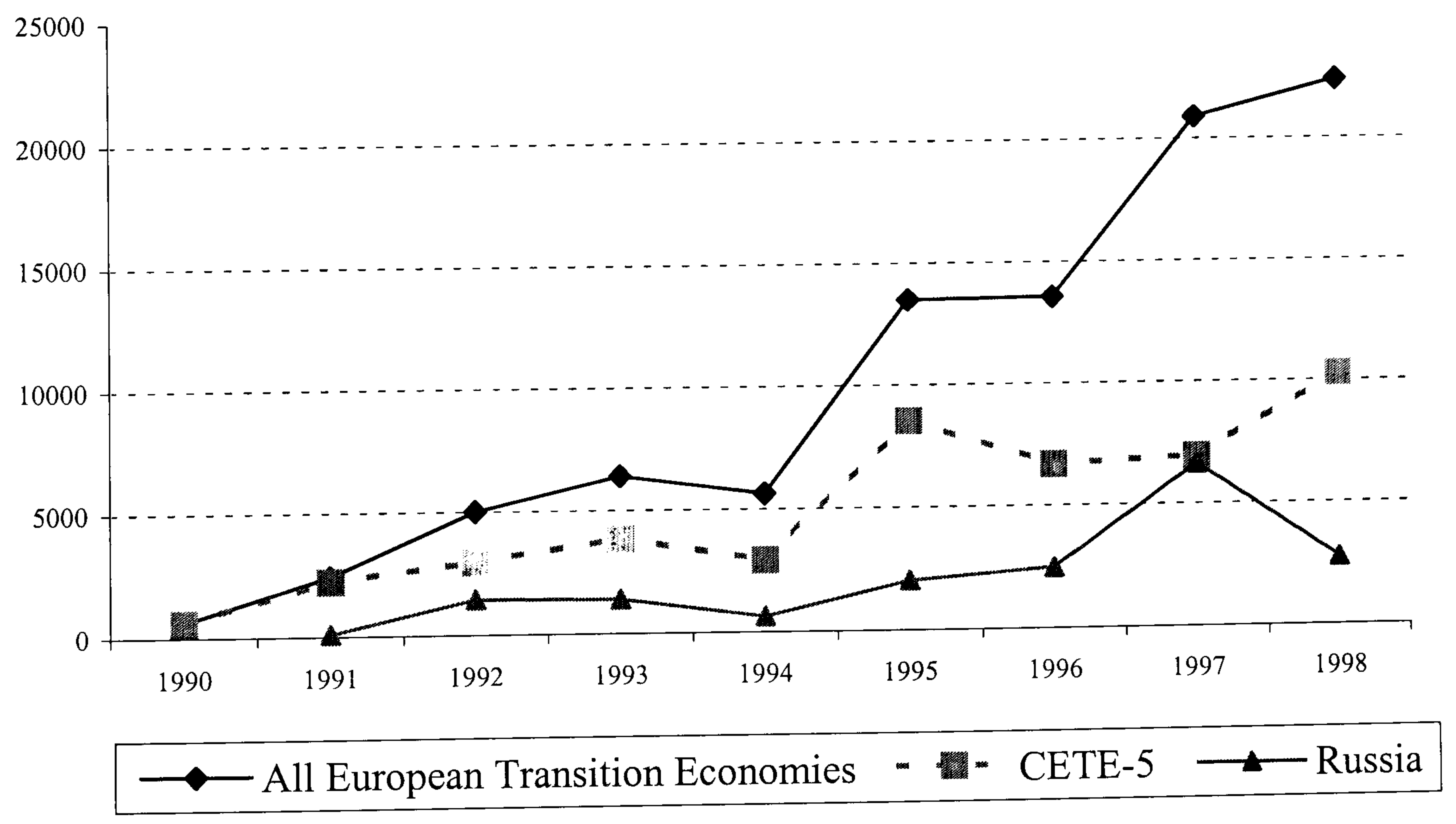
[b] Excludes external bonds

[113] Czech Republic, Hungary, Poland, Slovakia, and Slovenia.

[114] Between 1990 and 1998, FDI accounted for 34 per cent of capital inflows into the developing economies. Conversely, from Table 5.2 it can be calculated that between 1993 and 1998 FDI accounted for 43 per cent of capital inflows in CETE-5 and 26 per cent in the Russian Federation.

Despite being among the top 10 recipients, the group of developing countries that receive more than 70 per cent of FDI flows, FDI per capita in Russia has been disappointingly low. The FDI in Russia rose significantly with opening of its economy, but political instability and the poor business climate deterred many foreign investors. Fig. 5.2 indicates that, even though the trend of FDI was upward during 1990-98 period, it was much more significant in the five Central European Transition Economies (CETE-5) and in Central and East European (CEE) transition economies cumulatively than in Russia. This difference is much more pronounced if FDI per capita were considered instead. While all European transition economies received $439 in forms of cumulative FDI-inflows per capita between 1989 and 1997, Russia received only $63 for the same period (EBRD, 1998). That is many times less than any other European transition economies, except FYR Macedonia, and even less than an average ($84) of a country from the Commonwealth of Independent States (CIS). At the end of 1997 the total FDI stock in Russia was only half of the sum invested in Hungary between 1989 and 1997.

Fig. 5.2 Inflows of FDI in ECE Transition Economies, 1990-98 ($US millions)




Source: UN/ECE, 2000 and author's calculations.

The inflow of capital in Russia peaked in 1997. This was a result of the improvement in economic policy environment and financial position, together with successful rescheduling agreements with Paris and London Clubs creditors in 1996 and

1997 respectively. However, as most of these inflows were directed to short-term investment in government securities and equities, Russia became increasingly vulnerable to shifts in market sentiment. This weakness was forcefully manifested in the form of increase in the already sizeable capital outflows after the onset of the Asian crises in the late 1997. The widening of the gap between inflow and outflow of capital in Russia has culminated during and immediately after August 1998 crises and Russian default on the GKOs.

The analysis of the flow of capital in Russia during transition would be incomplete without considering external debt and its implication for stabilisation of economy. Table 5.3 demonstrates external debt and debt indicators for Central and East European (CEE) economies in transition in comparison to Russia in the 1990s.

Table 5.3 Debt Indicators for Economies in Transition, 1990-98, ($US billions)

| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|---|---|---|
| Russia/SU (before 1992) | | | | | | | | | |
| Total external debt (TED) | 59.8 | 67.8 | 78.4 | 111.7 | 121.5 | 120.3 | 124.9 | 126 | 183.6 |
| Long term debt | 48 | 55.2 | 65.2 | 103.4 | 111.6 | 110 | 112.8 | 120 | 165.2 |
| Concessional | 0 | 0.7 | 1 | 2.1 | 2.5 | 2.5 | 2.5 | 2.3 | 2.3 |
| Bilateral | 0 | 0.7 | 1 | 2.1 | 2.5 | 2.5 | 2.5 | 2.3 | 2.3 |
| Multilateral | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Official non-concessional | 5.9 | 8.8 | 10.8 | 54.6 | 64.5 | 64.3 | 72.9 | 74.2 | 85.3 |
| Bilateral | 5.5 | 8.4 | 9.3 | 50.8 | 58.8 | 52.7 | 57.6 | 55.7 | 59.4 |
| Multilateral | 0.4 | 0.4 | 0.5 | 1.3 | 1.5 | 2 | 2.8 | 5.3 | 6.6 |
| IMF credit | 0 | 0 | 1 | 2.5 | 4.2 | 9.6 | 12.5 | 13.2 | 19.3 |
| World Bank credit | | | | | 0.6 | 1.5 | 2.6 | 5.3 | 6.4 |
| Private creditors | 42.1 | 45.6 | 53.4 | 46.7 | 44.6 | 43.2 | 37.4 | 43.5 | 77.6 |
| of which | | | | | | | | | |
| Bonds[a] | 1.9 | 1.9 | 1.7 | 1.6 | 1.8 | 1.1 | 1.1 | 4.6 | 16 |
| Commercial banks[a] | 17.9 | 16.8 | 18.5 | 15.9 | 16.4 | 16.7 | 15.6 | 29.3 | 29.3 |
| Short-term debt | 11.8 | 12.6 | 13.1 | 8.3 | 9.9 | 10.4 | 12.1 | 6.1 | 18.4 |
| Memorandum Item | | | | | | | | | |
| IMF credits/TED (in per cent) | 0 | 0.0 | 1.3 | 2.2 | 3.5 | 8.0 | 10.0 | 10.5 | 10.5 |
| CEE | | | | | | | | | |
| Total external debt | 109.3 | 117.7 | 113 | 116.8 | 121.5 | 138.3 | 139.8 | 141 | 156.3 |
| Long term debt | 91.1 | 102 | 99.9 | 104.1 | 109.5 | 120.8 | 121.7 | 116.5 | 127.8 |
| Concessional | 5.2 | 4.9 | 14.3 | 13.6 | 12.1 | 13.6 | 12.8 | 10.5 | 11.5 |
| Bilateral | 5.1 | 4.7 | 14.2 | 13.4 | 11.9 | 13.3 | 12.5 | 10.1 | 11 |
| Multilateral | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.3 | 0.4 | 0.5 |
| Official non-concessional | 36.6 | 47.6 | 38.6 | 39.6 | 41.9 | 42.3 | 40 | 37 | 36.5 |
| Bilateral | 28.7 | 34.7 | 24.3 | 24.9 | 25.1 | 26.9 | 25.9 | 23.5 | 23.5 |
| Multilateral | 6.6 | 7.9 | 8.9 | 9.3 | 11.1 | 12.3 | 11.9 | 11 | 10.6 |
| IMF credit | 1.3 | 5 | 5.4 | 5.4 | 5.7 | 3.1 | 2.2 | 2.5 | 2.4 |
| Private creditors | 49.3 | 49.5 | 47 | 50.9 | 55.5 | 64.9 | 68.9 | 69 | 79.8 |
| of which | | | | | | | | | |
| Bonds[a] | 5 | 6.7 | 7.4 | 11.7 | 28.1 | 30.9 | 29.1 | 26.1 | 28.3 |
| Commercial banks[a] | 34.7 | 33.6 | 30.8 | 29.1 | 14.4 | 16.6 | 20.2 | 21.1 | 21.4 |
| Short-term debt | 18.2 | 15.7 | 13.1 | 12.7 | 12 | 17.5 | 18.1 | 24.5 | 28.5 |
| Debt Indicators (percentage) | | | | | | | | | |
| | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| Ratio of external debt to GNP | | | | | | | | | |
| Russia/FSU (before 1992) | 10.3 | 12.5 | 18.6 | 29.1 | 37.9 | 35.3 | 29.6 | 28.8 | 69.4 |
| CEE | 38.8 | 65.1 | 58.2 | 50.9 | 47.3 | 43.5 | 41.7 | 44.4 | 44.2 |
| Ratio of external debt to exports | | | | | | | | | |
| Russia/FSU (before 1992) | 73.8 | 124.8 | 143 | 169.8 | 156.7 | 129.5 | 119.3 | 121.4 | 207.1 |
| CEE | 179.4 | 214.9 | 165.5 | 141 | 121.8 | 103.3 | 98.3 | 100.2 | 103 |
| Ratio of debt service to exports | | | | | | | | | |
| Russia/FSU (before 1992) | 14.6 | 42.8 | 2.5 | 3.3 | 4.4 | 6.4 | 6.7 | 6.4 | 12.1 |
| CEE | 20.9 | 19.5 | 16.8 | 11.7 | 14.4 | 13.6 | 13.5 | 14.1 | 15.9 |

Source: UN 2000; IMF, 1999

*Note:* [a] Government or government-guaranteed debt only

Notably, the total external debt of Russia equalled the corresponding debt for all other CEE transition economy in 1994, and surpassed it in 1998. In addition, Table 5.3 implies that in contrast to other CEE economies the role of official creditors in Russia and that of the IMF, in particular, has become more important over time. However, again in contrast to the rest CEE economies the official financing to Russia was not significant in the first years at the beginning of transition. Arguably, that was the time when Russia most needed it. Furthermore, one can argue that the size of IMF lending to transition economies has been hardly excessive (Table 5.4).

Table 5.4 Net IMF Lending to Transition Economies, By Facility, 1990-98, ($US bn.)

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Source: UN, 2000.

As demonstrated in Table 5 actual foreign currency disbursements relative to either Gross National Product (GNP) or to Total External Debt (TED) are not particularly high, even in the period when these achieved their peak. Moreover, as far as Russia is concerned, the size of official disbursements rarely matched promised finances (see section 7). The total IMF foreign currency disbursements to Russia from the beginning of transition until the end of 1998 had been just over $20 billion (IMF, 1999, and author's calculations).

Table 5.5 Foreign Currency Disbursements to the Russian Federal Government, 1994-98 ($US mill.)

| Creditors | 1994 | 1995 | 1996 | 1997 | 1998 | Total (1994-98) |
|---|---|---|---|---|---|---|
| Multilateral | 1,931 | 6,319 | 4,940 | 4,777 | 7,519 | 25,486 |
| IMF[a] | 1,544 | 5,450 | 3,758 | 2,019 | 6,240 | 19,011 |
| World Bank | 280 | 826 | 1,107 | 2,699 | 1,219 | 6,131 |
| EBRD | 6 | 43 | 75 | 59 | 60 | 243 |
| Other | 101 | 0 | 0 | 0 | 0 | 101 |
| Bilateral | 2,057 | 1,554 | 3,280 | 1,375 | 2,110 | 10,376 |
| Tied | 2,057 | 1,554 | 1,090 | 1,375 | 2,110 | 8,186 |
| Untied | 0 | 0 | 2,190 | 0 | 0 | 2,190 |
| Bonds[b] | 0 | 0 | 1,000 | 3,549 | 9,615 | 14,164 |
| Suppliers/other commercial | 507 | 93 | 0 | 1,136 | 156 | 1,892 |
| Total | 4,496 | 7,966 | 9,220 | 10,836 | 19,399 | 51,918 |
| (excludng IMF) | 2,952 | 2,515 | 5,462 | 8,817 | 13,160 | 32,907 |
| Memorandum Items | | | | | | |
| GNP | 320,580 | 391,784 | 472,297 | 489,583 | 225,216 | |
| Total External Debt (TED) | 121,500 | 120,300 | 124,900 | 126,000 | 183,600 | |
| IMF disbursment/GNP | 0.48 | 1.39 | 0.80 | 0.41 | 2.77 | |
| IMF disbursment/TED | 1.27 | 4.53 | 3.01 | 1.60 | 3.40 | |
| Multilateral/GNP | 0.60 | 1.61 | 1.05 | 0.98 | 3.34 | |
| Multilateral/TED | 1.59 | 5.25 | 3.96 | 3.79 | 4.10 | |

Source: IMF, 1999, author's calculations

*Note:* [a] Full amount of Fund purchases. In 1998 part of this amount was disbursed directly to the CBR.

[b] Figure for 1998 includes $3,700 of Eurobonds purchases by residents. Data on resident purchases in other years were not available.

Nevertheless, it is not only IMF credits that were important for Russian financial consolidation. As mentioned above, one has to consider the growing role of private financing and other sources of official financing, particularly bilateral and multilateral credits as shown in Table 5.3. This might not have come had Russia not received the green light for her reforms by the IMF. In addition, prior to August 1998 crises Russia had reached key rescheduling agreements with Paris and London Clubs creditors.

Table 5.6 Multilateral Debt Relief Agreements with Official Creditors, 1990–98.

| | | Consolidation period for current maturities | | | | | Repayment terms[a] | |
|---|---|---|---|---|---|---|---|---|
| Date of Agreement | Contract cutoff date | Start date | Length (months) | Arrears included | Share of debt consolidated (percent) | Amount consolidated (mill. $US) | Maturity (years/ months) | Grace (years/ months) |
| 2-Apr-93[b] | 1-Jan-91 | 1-Jan-93 | 12 | Y | 100 | 14497 | 10/0 | 6/0 |
| 2-Jun-94 | 1-Jan-91 | 1-Jan-94 | 12 | | 100 | 7100 | 15/2 | 2/9 |
| 3-Jun-95 | 1-Jan-91 | 1-Jan-95 | 12 | | 100 | 6400 | 15/4 | 2/10 |
| 15-Apr-96 | 1-Jan-91 | 1-Jan-96 | Stock | | 100 | 40200 | 21/5 | 2/11 |
| 6-Oct-97 | 1-Jan-91 | 1-Jan-97 | N/A | | N/A | 32500 | 25 | 6 |

Sources: IBRD/The World Bank, 1999; Hishow, 2001.

*Note*: The figures in this table are commitment values (amounts of agreed debt relief). They should correspond to the disbursement figures (minus debt forgiveness, when applicable). All agreements shown in this table were negotiated either through the Paris Club or through the London Club.

[a] Maturity is measured here from the end of the consolidation period to the date of the final amortisation payment; the grace period is the time between the end of the consolidation period and the date of the first amortisation payment. The secretariat of the Paris Club measures the grace and maturity from the midpoint of the consolidation period.

[b] Agreement follows the deferral signed in January 1992 by the former Soviet republics.

The agreements shown in Table 5.6 allowed a substantial lengthening of the maturity structure of sovereign debt[115] and reduced debt service pressures. Moreover, after two years London Club wrote off one third of the debt due in February 2000, as well as accepted an interest service reduction (Hishow, 2001). Consequently, the real payments amounted to just 40 percent of the due payment as shown in Table 5.7.

[115] The sovereign debt alone makes Russia one of the most indebted emerging markets in the world. Only Brazil ($220 bn.), Korea ($170 bn.) and Indonesia ($169 bn.) run bigger debts (Hishow, 2001).

Table 5.7 Financial Relief Through Restructuring and Payment Deferrals, ($US bill.)

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Source: Hishow, 2001

The reduced debt service expenditures, totalling $80 billion, which is about a half of the Russian GDP for 2000, are claimed to be significant contribution of the West to the balance of payments (Hishow, 2001). Moreover, Hishow (2001) argues that the size of the Russian external debt may allow Russia to misuse her dominant position as a debtor and default on her external obligation as it did with the internal debt in the wake of August 1998 crises. The worry for the West is that Russia may impose either a unilateral moratorium or try to achieve an infinite debt restructuring, which in the end may result into the same. It could be argued that continuing lending to Russia despite unsustainable policies may be based in part on expectations of support of international financial community. In other words, there is an implicit moral hazard where creditors continue investing in Russia led to believe that Russia is too big to be allowed to fail. Reportedly, in the wake of Russian financial 1997-98 crises, the IMF's sceptical officials were persuaded by the United States Treasury to provide a loan package on the ground that Russia was "to nuclear to go bust" (Hale, 1998). It is therefore always difficult to determine the optimal level of financial assistance for any country and particularly for Russia given her military might and vast economic resources.

The IMF faced the same dilemma when determining the size of the rescue package for the financial crises of 1997-98. On one hand sufficient financing was necessary to meet anticipated foreign exchange needs, restore market confidence, and ensure the success of the program. On the other hand the provision of very large amount of finance risked moral hazard. From July 1997 to October 1998 the international community pledged about $187 billion to support Indonesia, Korea, Russia, and Thailand (Table 5.8). However, due to the performances under IMF-agreed reform programs the disbursements amounted to about one third of the pledged funds for all countries. In the event, due to the disappointing results of the Russian reforms only the first tranche of the IMF loan ($4.5 billion) was disbursed. That represented about seven percent of the total disbursements, and was about a quarter of the pledged sum to Russia. Following mounting fiscal and financial difficulties, August 1998 ruble devaluation, unilateral restructuring of the GKO debt and the declared 90-day moratorium on private debt repayments, and ongoing weakness in oil prices, the flow of financing was cut off for a period of time.

Looking at Table 5.8 one cannot help noticing that the funds pledged to Russia are considerably smaller than the funds designated for any other country except Thailand. Moreover, the disbursed funds to Russia are much smaller than for any other country under consideration. This observation led Hale (1998) to claim that the Russian package was too small to be effective. According to Hale (1998), had the $22 billion package for Russia been similar to the Mexico one of $40 billions in 1995, investors would probably not fled? Furthermore, had more of these fund been disbursed the investors would have been less sceptical? In the event, investors judged that, given the delicate finances of Russia, the pledge of $22 billions and even considerable smaller actual commitments, was not enough to bail Russia out.

Table 5.8 Rescue Package in East Asia, Russia, and Brazil: 1997:07-1998:10 ($US bill.)

| | Funds pledged | | | | | Funds disbursed | | | |
|---|---|---|---|---|---|---|---|---|---|
| Country | IMF | Multilateral[a] | World Bank | Bilateral | Total | IMF | World Bank | Others | Total |
| Indonesia | 11.2 | 10 | 5.5 | 26.1 | 47.3 | 6.8 | 1.3 | 1.4 | 9.5 |
| Korea, Rep. Of | 20.9 | 14 | 10 | 23.3 | 58.2 | 18.2 | 5 | 4 | 27.2 |
| Thailand | 4 | 2.7 | 1.5 | 10.5 | 17.2 | 3 | 0.8 | 8.9 | 12.7 |
| Russia | 11.2 | 1.5 | 1.5 | 9.9 | 22.6 | 4.5 | | | 4.5 |
| Brazil | 18 | 9 | 4.5 | 14.5 | 41.5 | 4.6[b] | | 4 | 8.6 |
| Total | 65.3 | 37.2 | 23 | 84.3 | 186.8 | 37.1 | 7.1 | 18.3 | 62.5 |

Source: IBRD/The World Bank, 1999.

*Note:* [a] World Bank, Asian Development Bank, and Inter-American Bank.

[b] Package was approved in Dec. 1998. First IMF disbursement was in January 1999.

The evidence presented here give credence to claims that Western aid to Russia was not sufficient to enable Russia to go through the pains of transition smoothly (Sachs, 1997; Hale 1998). In fact the Western contribution to Russia could hardly be qualified as "aid". It is clear that those were credits which Russia needs to repay sooner or latter. Though these credits seem cheaper than those taken on the financial markets, the Russian government was expected to accept the conditions formulated by IMF ideologues and policy-makers.

### 5.6 Common Criticism of the IMF Programs

Although every society has it own priorities, broad objectives of economic policy are usually not in dispute. These should include a high rate of growth, low rate of inflation, alleviation of poverty, social stability, adequate supply of public goods and services, and not too wide income inequality. Criticism of the IMF takes various form and along several lines. In most general form, the critics finds the first three elements of a typical IMF program outlined above in dissonance with the broad objectives of economic policy.

One of the strides of this line of criticism is the view that the macroeconomic underlying the IMF approach to stabilisation is fundamentally wrong (Taylor, 1988). Taylor's criticism is rooted in the contrasting view about the nature of inflation, the relative importance of fix-price and flex-price markets, the role of forced saving and output adjustment, dynamics of economic growth, and the sensitivity of specific balance of payments and financial linkages to various policy measures.

Another line of criticism views the Fund as a hermetic institution whose standard stabilisation package is not sufficiently responsive to the ever-changing conditions in the global economy and the evolution of professional thinking. More specifically, the 'financial programming' based on the Polak (1957) model is viewed as to some extent dogmatic, somewhat outdated and rather ill suited for the diverse crises such as collapse of central planning and the financial crises in Asia and Latin America in the 1990s (See Taylor, 1998 for more details).

Other strand of criticism aims at the structural elements of a reform package. The critics charges that the Fund's staff lacks expertise and mandate to convey advice and design conditionality on structural issues.[116] It is argued (Feldstein, 1998) that the legitimate political institutions of the country should determine the nation's economic

[116] See Mussa and Savastano (1999) for the references of the critics.

structure and the nature of its institutions rather than the IMF via conditionality provisions. As argument goes, the IMF role should be limited to providing technical advice and limited financial assistance. Subsequently, the desperate need of financial assistance does not give the IMF the moral right to substitute its technical judgements for the outcomes of the nation's political process (Feldstein, 1998).

Yet another thread of criticism identifies two major interconnected asymmetries of the IMF operating practices (Soros, 2000). One is a disparity between crises prevention and crises intervention; the other is disparity in the treatment of lenders and borrowers. The first disparity stems from the fact that the IMF cannot provide any debt relief to the debtor countries during the crises since that could have devastating effects on the financial markets (Soros, 2000). Only after the crisis is weathered, can any debt relief follow. The second disparity is explained by the political economy of the IMF. Namely, Soros (2000) asserts that international financial architecture is skewed towards centre. It implies the countries at the centre of the global financial system control the IMF; therefore it would go against the national interest of controlling shareholders if the IMF penalised lenders. The net effect of this approach is to place the burden of adjustment mainly on the borrowing countries by compelling them institutionally to service their debt, which usually stretches them to the limits of their capacity. This feature of the IMF reportedly had an important role in shaping investors expectations in Russia in 1998 (Soros, 2000). Namely, many investors kept buying Russian treasury bills (GKOs) despite the fact that fiscal and monetary indicators were clearly indicating a possible crisis. Their actions were influenced by the view that Russia was too important not to be allowed an IMF bail out. In the event, according to Soros (2000), the very recognition of the moral hazard inherent in the IMF method of operation made the bail out politically unacceptable. Subsequently Russia was doomed for the default and the GKOs holders for the financial disaster.

## 5.7 Specific Policy Consideration of the IMF Involvement in Postcommunist Russia

The themes 'what went wrong' and 'who lost Russia' have been prominent in the literature for several years. The answers on these questions may be a useful lesson for policy analysts and many others on both sides of the Atlantic but its beyond scope of this study.[117] Instead we proceed with enlisting specific potential errors on the part of the IMF in Russia.

*Error* 1. IMF policies contributed to short-termism in policymaking and diverted attention from strategic policy making. The priorities for the IMF, irrespective of changes in conditionality, seem to be short-term financial performance criteria. More precisely, the IMF tends to impose (quarterly) ceilings on the nominal value of the fiscal deficit, (quarterly or even monthly) ceilings on the expansion of net domestic credit of the central bank and (quarterly) floors on net international reserves. Such policies tend to keep the time horizon of policy makers fixed on the very short term.

*Error 2*. A huge underestimation of corrective inflation after liberalisation of prices in January 1992. While the IMF and the Russian Prime Minister estimated the size of monetary overhang about 50 per cent (Gros and Steinherr, 1995) and price jump of not more than 100 percent (Rossiiskaya Gazeta, 1992), respectively, the prices jumped as much as 245 percent in January 1992. As elaborated in Chapter 1, one of the probable causes of this miscalculation should be sought in the use of sophisticated models of the demand for financial assets that give quite good results over the long run in developed market economies (Gros and Steinherr, 1995). However, these models proved inadequate in Russia and other transition economies, were households had essentially only three assets: cash, saving deposits and foreign currencies. Another probable cause for the miscalculation of price jump was reliance on the velocity of saving deposits rather than the velocity on cash, because the former proved to be much more variable than the latter (Gros and Steinherr, 1995). The error regarding the corrective inflation was not incurable, but it clearly helped to undermine the credibility of the Gaidar's government budget for the first quarter of 1992.

*Error 3*. The IMF initial support for the Ruble zone, an arrangement for 15 former Soviet Republics (FSR) to continue to use a common, unconvertible currency, the Soviet ruble, upon the break up of the USSR in December 1991, was a costly mistake. This poor advice was intended to minimize dislocation of central planning's organic enterprise links between these states. That implies smaller trade shocks and lower fall in output. In addition, the IMF considered other non-Russian republics unfit to manage their own currencies (Sachs, 1997). The IMF's explanation is that it tried to limit the inflation rate by providing a 'set of rules for a coordinated monetary policy' (Hernández-Cata, 1995). The Ruble zone

[117] Interested reader is referred to various articles edited by the former Russian advisers like Anders Åslund; Gros and Steinherr (1995); Soros (2000); and Stiglitz (2002).

probably not only did absorb some of the trade shocks between these states, but also safeguarded some of the non-Russian industries from immediate collapse. These industries were able to obtain unauthorized credits ('non-cash' rubles) from the Central Bank of Russia via national central banks. The dual money system, characterized on one hand, with soft supply of non-cash credits and a hard constraint on the delivery of cash on the other, was particularly costly to Russia in the first year of transition. Credits to other FSRs amounted in 1992 to at least 8.5 per cent of Russian GDP if delivery of cash is excluded, and 11.6 per cent otherwise, in terms of the CBR credits alone (Granville, 1997). Needless to say, such substantial increase in money supply inevitably fed into higher prices and much aggravated stabilization efforts. Although it has four distinct phases, the destabilizing effects of the Ruble zone prevailed until November of 1993. In July of 1993, the CBR suddenly withdrew pre-1993 ruble notes, which together with the collapse of negotiations between Russia and Kazakhstan in November 1993 effectively sealed the fate of the old Ruble area.

*Error 4*. Financial support for Russia was inadequate for the successful stabilisation in the early stages of reforms. This point is not however, shared unanimously among economists. Sachs (1997) for example argued that the West should have financed Russian budget deficit of the order of 5 per cent of GDP. Instead, the IMF maintained that Russia should aim for a balanced deficit. According to Sachs (1997), the expectation that, amidst deep transformation crises, Russia could slash budget deficit below levels observed in almost all OECD countries, were utterly unrealistic. Along similar lines Portes (1994) argued that the main policy error was in the ever-emphasis on macroeconomic policy itself. Gomulka (1995) holds that Portes assessment is an exaggeration and that in fact, while helpful, the external financial support is not essential for the successful stabilisation. Similarly, since the financing of budget deficit should be mostly repayable, Hernández-Cata does not recommend such course of action.

Whatever merits for the larger or smaller external assistance may be, the fact remains that the West, principally via the IMF, has consistently failed to live up to their promise from the very beginning of its involvement in Russia. At the beginning of 1992, Russian reformist government was promised US $ 24 billion of Western aid, to be disbursed in the second part of that year. The implications of a sophistic use of term aid were rendered obsolete since hardly anything of the promised assistance was delivered in 1992. More precisely, neither $ 0.719 billion IMF stand by arrangement, or $ 6 billion exchange rate stabilisation fund, or an official debt rescheduling deal materialised except an interim IMF credit of $ 1 billion disbursed in August 1992 for the reserve purpose only (Granville, 1995). In addition, the $ 670 million assistance approved by the World Bank in 1992, was not disbursed until the end of 1993. This assistance failed to be materialised at the time of the adverse political climate for the reformist government, so that at the end of 1992 the reformist Prime Minister was forced to resign. Subsequently, the reforms lost an appeal and a slowdown of the momentum of the reform was unmistakeable at the beginning of 1993 (Granville, 1995).

The $28 billion 'aid' package announced in July 1993 had a similar fate to the $24 billion announced in April 1992. None of these two packages were ever properly elaborated or delivered (Sachs, 1997). Sachs (1997) further argues that both G7 and the IMF failed to understand Western financial assistance for the Russian budget was a *conditio sine qua non* to achieve financial stabilisation.

In July 1997 the IMF pledged yet another "aid" package of $22 billion to Russia. In the event only $4.7 billion of this package was disbursed. Investors seem to have viewed this package to small to bail Russia out, so they fled. As mentioned above, Hale, (1998) argued that had this package been as large as the $40 billion package for Mexico in 1995, investors probably would have not fled.

IMF's advocates would argue that the reason for the discontinuity of disbursement of the pledged funds by the IMF was the failure of the Russian government to consistently hit agreed targets. The counter argument however is that the targets were unrealistic i.e., balanced budget (Sachs, 1997), and government was never likely to achieve them.

*Error 5*. Contrary to its positive experience with the two stage Polish partial debt cancellation, the West has failed to write off at least a part of old Soviet debt. Instead, Russia inherited all of the old era ex Soviet debt and was expected to duly service it. Consequently, the debt obligation added substantial strain to the long-suffering and deteriorating government finances. The issue of forgiveness of debt always critically hinges on the prevalence of a good will. Advocates of the IMF policies usually argue that the public opinion in the Western democracies did not rise to this historical opportunity and were not willing to bail Russia out of the hole (Hernández-Cata, 1995).

*Error 6*. Sachs (1997) argues that, in addition to the failure to provide a significant financial assistance to Russia, the IMF failed to incorporate in the programme non-monetary means of financing the budget deficit. These could have included Treasury bills and bonds. The trouble with these instruments is that their rate of return needs to be very high to make them attractive. This in turn increases the interest burden on government finances and enlarges the deficit in the long run. Unless the rate of return comes down significantly, the government finances may be seen as unsustainable, prompting a run on currency, or even a default. Despite this unpleasant arithmetic, non-monetary financing of a budget is largely perceived as less detrimental to a national economy than a monetary one. Yet, there was not significant non-inflationary financing of deficit in Russia in the first years of transition.

*Error 7.* Failure to recognise prevalence of both inflation inertia and inflationary expectations before summer of 1995, on the part of the IMF, led to adoption of classic money based stabilization, as argued in Chapters 2 and 3. This proved not to be the wisest policy choice (Nikolić, 2000b; Nikolić, 2001). Instead, pegged exchange rate based stabilization coupled with heterodox elements would have been more likely to break both the inertia and the expectation, as experience after Jun 1995 has shown. Admittedly, such a policy option would have required sizable foreign exchange reserves, which Russia was lacking at the time. However, this is exactly where external financial support ought to have played its role. After all, one of defining roles of the IMF ought to be to provide a short-term liquidity to countries with ailing finances.

*Error 8.* The existence of bilateral causality between inflation and broad money in postcommunist Russia, as documented in Chapter 4, may also imply that the latter may not be an effective intermediate target for the former (Nikolić, 2000b). In other words, the existence of feedback or bilateral causality between inflation and broad money supply makes latter unsuitable for monetary targeting. This is because the target cannot provide an unambiguous signal of where policy actions are headed. Yet, monetary targeting was a central piece of early stabilisation efforts guided by the IMF. In effect, monetary targets were imposed in the non-monetary economy (Soros, 2000). Consequently not only monetary target were bound to be pervasively missed, but also even when they were met, that did not imply that inflation was under control.

We consider that all of the errors enlisted above were related to the IMF approach rather then possible implementation failures. Possibly, we could classify error 4 as an error, both in design and implementation. In contrast, Gomulka (1995) argues that most of the errors were in implementation rather than in design.[118] The IMF advocates would argue that their recommendations were good but were never fully implemented. However, as pointed out by Stiglitz (2002), in economics it is impossible to follow a prescription precisely. Instead, good policy guidelines should take into account what is feasible to achieve given complex political processes and fallibility of individuals.

The policy errors outlined above significantly contributed to a delay in stabilisation efforts. According to Sachs (1997), succeeding efforts to stabilise the economy were made more difficult and more costly. Primarily, having lost credibility in the ruble, the Russian public engaged in massive capital flights throughout 1990s (Table 5.9). In addition, this loss of confidence made it more difficult to finance the budget deficit by non-monetary means. In particular, the public was unwilling to buy Russian treasury bills except at enormously high interest rates. Likewise, the decline of the broad money to GDP ratio increased inflationary consequences for any given level of financing of the budget deficit by the Central Bank of Russia. Secondly, Sachs (1997) argue that as a result of the delay in stabilisation, tax evasion and tax exemption have swelled a great deal contributing to a significant decline in the tax collections. That made the aggravated budget predicament even graver. The third consequence of the delay in stabilisation according to Sachs (1997) is that the regional governments have managed to capture an ever-growing share of total revenue on expense of the federal government. Hence, this too further aggravated the financing of the budget deficit.

Table 5.9 Capital Flight (Net Errors and Omissions) in Russia, 1994-98 ($ bill.)



Source: IMF, 2000.

A particularly strong criticism of IMF conduct in Russia came from the Nobel Prize winner, Joseph Stiglicz who was the chief economist in the IMF's sister institution; the World Bank. Stiglitz, 2002, argues that the IMF has helped creation of 'ersatz capitalism' in Russia which instead of providing incentives for wealth creation and economic growth was rather conductive for asset stripping. This particular kind of 'Wild East' capitalism

[118] Apparently, the same members of the IMF team had much more success in Poland than in Russia. Gomulka (1995).

was, according to Stiglitz, 2002, result of various mistakes of the Washington consensus such as disregard for competition policies, errors in sequencing of reforms, excessive zeal in fighting inflation, and shunning aside issues of poverty, inequality and social capital. Lack of competition policies and failure to create the institutional structure for a market economy resulted in privatised firms' ability to establish monopolies and cartels. Price liberalisation before privatisation wiped out savings and imposed stabilisation. As the argument goes, stabilisation prevented growth because it imposed high interest rates which led to asset stripping because it was too expensive to expand. Asset stripping was also helped by the privatisation done the 'wrong way' and liberalisation of the capital markets. Privatisation 'as quickly as possible', no matter how, also was responsible for the decline in income and increase in inequality. Stiglitz, 2002, further argues that the IMF's loans to Russia were harmful because these set back a deeper reform agenda. The loans left the country more indebted and impoverished, maintained an overvalued exchange rate, and deliberately intervened in the political life of the country (Stiglitz, 2002).

### 5.8. Alternative Medicine of the IMF: More Prescriptions, Less Injections

Given these specific policy mistakes and the controversial role of the IMF in Russia, one wonders why a developing country needs the IMF support. Literature offers three important reasons for the IMF role in today's economy (Hale, 1998). First, the IMF offers macroeconomic and other policy advises that politicians can sell as their own. Even though the public is aware that the US Treasury and other G-7 countries heavily influence the Fund, it still offers impression of autonomy so that the Funds highly specialised and renowned officials make policy advice more politically acceptable to borrowers. Second, in the present global financial environment the Fund acts as a lender of last resort, similar to the role of central bank during domestic banking crises. Consequently, the Fund can step in the time of financial crises to help the troubled economy bridge short-term liquidity problems and restore investors' confidence. Third, the IMF could also initiate microeconomic reforms that might otherwise be politically unacceptable. The emphasis of this kind of microeconomic reforms is supposed to be on the non-inflationary economic growth.

In addition to these three standard roles of the Fund in today's economy, its role of a provider of credibility could not be over-emphasised (Cottarelli and Giannini, 1998).

Instead of delegating monetary policy to domestic entity, the alternative way of enhancing credibility of adjustment policies in developing countries is to surrender those policies to approval of a supranational organisation such as the Fund. The growing role of the Fund as the provider of credibility, rather than lender of resource only, is supported by the three pieces of evidence given by Cottarelli and Giannini (1998). First, the share of net IMF credit over total net external financing (including FDI) to developing countries dropped from $4^{1/4}$ percent during the 1980s to less than 1 percent during 1990-96. Second, the number of precautionary programs has increased in recent years: at the end of 1996 one third of the stand-by and Extended Fund Facility (EFF) arrangements were precautionary, that is, they had been undertaken without any intention of drawing. Third, the ratio between actual and potential borrowing in all outstanding IMF arrangements has declined since 1980s, while the number of countries with programs has risen to historical peaks. Overall, the Fund's stamp of approval has been in demand to enhance the authorities' credibility and to give a clear signal to investors that a country is relatively safe for investing.

## 5.9 Conclusion

Transformation of a world super power into a market economy, after three quarters of century of central planning, represented an unprecedented task with an unpredictable outcome. This process in the Russian Federation turned out to be long-drawn-out and agonizing with a less than desirable outcome. Yet, despite being characterised as a country of 'robber capitalism' rather than market economy, Russia is nowadays well away from the central planning and the kind of autarky most people dreaded of. The Russian style capitalism was brought about by Russian reformers supported by the West and guided by the IMF. The IMF prescribed medicine and the West seems to have spoon-fed Russia just enough to pass the benchmark of no return to the previous system.

The downside of the process, as argued in this chapter, was that prescription has often been inappropriate and the medicine quite inadequate. Even when the prescription might have been right, the patient was usually nourished too little too late.

One should bear in mind that the great share of responsibility for less than desirable outcome of the reforms should be sought within leading political forces in the country at the time. Not only were they errant but also they found their own interest in consistently postponing the true reforms. Reformers sins aside, this chapter argues that the IMF has been less than generous as far as the financial and good technical assistance is concerned. More precisely, as a represent of the West, the IMF has consistently underestimated the size of the assistance needed for the successful stabilisation in Russia. In addition, on account of conditionality, the IMF disbursed by a long way fewer resources than pledges, not to mention lack of desire for debt forgiveness. Furthermore, all of the Russian stabilisation programmes had an IMF approval and all of them failed. Moreover, the IMF has arguably made a significant number of specific policy mistakes that have inevitably aggravated long suffering Russian economy exposed by the pains of transition. Admittedly, transition process was a unique process and errors were inevitable. Nevertheless, given the reputation and enviable resources of the IMF, one cannot help thinking that they could have done much better and that at least part of the Russian socio-economic pains during transition were not inevitable.

## Final Conclusions and Directions for Further Research

This thesis has scrutinized critically and rigorously inflation process in post-communist Russia, the strength, dynamics, and causality of the relationship between inflation and various monetary aggregates as well as the role of the IMF in that process. From the methodological point of view, the emphasis of the study is on application of a modern empirical analysis including rigorous econometric testing of the results.

In contrast to earlier claims, this study clearly demonstrates that lagged inflation in postcommunist Russia is a very important determinant of the contemporaneous rate of inflation. In both, ADLM and ARMA models of inflation expectations, presented in the thesis, lagged inflation rates accounts for more than 90% of the variations in the contemporaneous inflation. Economic agents can easily utilize both of these simple models to make consistent forecasts of a one-month ahead inflation rate. Unsurprisingly, even though they are unbiased and weakly efficient, these forecasts are shown not to be rational in the strong form of efficiency.

The rigorous analysis of the relationship between various monetary aggregates and inflation, undertaken in this thesis, supports the main thesis that, broad money growth have the strongest correspondence to contemporary inflation in post-communist Russia. However, we found this relationship to be unstable, and sensitive to changes taking place in the new economic and institutional environment. In addition to other evidence about changes in this relationship, the summary statistics presented in the thesis suggests that, the average speed of transmission from changes in the growth of ruble broad money to inflation have increased from just over three months to just short of five months as Russia embarked on a path of macroeconomic stability soon after the exchange rate crises of October 1994. Similarly, the summary statistics also reveal that, changes in the growth of broad money had a considerably greater impact on prices in the period before October 1994, than in the period thereafter. Furthermore, the lack of overall significance of the coefficients of money in this later period points to a break in the systematic pattern of money price relationship, which was observed two and a half years after price liberalization in Russia. In contrast, the impact of changes in the previous month's inflation rate on current inflation does not abate. The overwhelming influence of this impact signifies the existence of the considerable inflation inertia prevalent in the Russian economy and the persistence for inflation shocks. This result calls for the inclusion of the one-month lagged inflation variable in the inflation model. Hence, the ADL model of inflation including $m2x$ avoids the shortcomings of some of the representations in the previous literature. This model also provides a reasonably good short hand description of the fundamental inflation process in Russia.

After assessment of various criteria for the optimal choice of the lag length in causality testing, this study found the Akaike's (1969) *FPE* criterion to outperform both the ad hoc and the statistical criteria under consideration. In addition, the results indicate that arbitrary lag length specifications, including the most common 4-4 and 8-8 ones, may give seriously misleading results in causality testing. Leaning on these results, the study clearly demonstrates the existence of feedback or bilateral causality between inflation and both aggregates of broad money in postcommunist Russia.

Our analyses of macroeconomic instability in postcommunist Russia lays heavy emphasis on the necessity of coordination of fiscal and monetary policies. The formal analysis demonstrates that monetary authorities are prevented from successfully fighting inflation by itself if the fiscal authority persists in running a net-of-interest budget deficit.

All the main empirical findings that emerge from the thesis are analysed in terms of their implications on economic policy. The empirical results imply that macroeconomic policies adopted in Russia under auspices of the IMF, during period under consideration, may not have been optimal. In particular, the study argues that lack of coordination of fiscal and monetary policies considerably contributed to the failure of all stabilisation programs implemented prior to August 1998. In addition, having identified a high degree of inflation persistency in Russian economy, unstable relationship between money supply and inflation with transmission of monetary impulses to future inflation becoming both, slower and weaker, and the existence of feedback or bilateral causality between inflation and both aggregates of broad money, this study implicitly suggests that, instead of the money-based stabilizations, exchange rate based stabilization with heterodox elements might have been more suitable for this transition economy.

Furthermore, this study also argues that the IMF, under whose auspices Russian macroeconomic policy was conducted, has been less than generous as far as the financial and good technical assistance is concerned. More precisely, as the represent of the West, the IMF has consistently underestimated the size of the assistance needed for the successful stabilisation in Russia. In addition, on account of conditionality, the IMF disbursed by a long way fewer resources than pledges, not to mention lack of desire for debt forgiveness. Furthermore, all of the Russian stabilisation programmes had an IMF approval and all of them had failed. Likewise, the IMF has arguably made a significant number of specific policy mistakes that have inevitably aggravated long suffering Russian economy exacerbated by the pains of transition. However, despite all of that, the IMF seems to have spoon-fed Russia just enough to pass the benchmark of no return to the previous system.

The contribution of this thesis lies in the combination of the fields Applied Economics and Economic Policy. In the rigorous analysis of the relationship between money supply and inflation in postcommunist Russia, this thesis clearly demonstrates that not only this relationship was unstable but also transmission of monetary impulses to future inflation became both, slower and weaker in the lower inflationary environment that emerged in Russia in 1994, and especially in 1995.

The results of assessment of various criteria for the optimal choice of the lag length in causality testing presented in the thesis, indicate that arbitrary lag length specifications, including the most common 4-4 and 8-8 ones, may give seriously misleading results in causality testing. That may have severe consequences for economic policy, particularly in cases where some kind of intermediate targeting is exercised, as in Russia in a few years after price liberalisation.

Given the lack of experience with open inflation on the part of economic agents in majority of transition economies, the literature on the formation of expectations in these economies is still rather scant. This thesis gives a systematic elaboration of the formation and rationality of inflationary expectation in postcommunist Russia. The findings of this study sharply contrast the claims that lagged inflation has been relatively unimportant in explaining inflation in transition economies.

Finally, the results of the empirical finding presented in the thesis give ground for a debate about appropriateness of Russian macroeconomic policies during transition. The role of the IMF, under whose auspices these policies were conducted, is particularly scrutinised.

Even though our sample period of six and a half years, was the longest considered at the time of writing the thesis, it may still be considered too short for meaningful analysis, particularly in times of major transformation of not only the economic system but also the entire country and region. In addition, as pointed out by many researchers, Russian statistics must be used cautiously so that we should not rule out the possibility of model misspecification due to erroneous data. Further research of the subject would inevitably benefit from the longer and revised data series. It is very likely that financial crisis of August 1998 caused a structural break in inflation series which is an additional avenue for the research of inflation in postcommunist Russia. It is also likely that this would also have implications for the reappraisal of the relationship between money supply and inflation in this transition economy. Cointegration and error correction model may be well suited to deal with any exogenous shift variables. Needless to say, the 1998 financial crises may well have important implications for the modelling of inflation expectations. Even though both of our models of inflation expectations seem to exhibit desirable statistical properties, the notable volatility of inflation in Russia in the given sample, indicates that this phenomenon may alternatively be duly modelled by Markov-switching model. In contrast to conventional modelling, this approach makes explicit allowance for the possibility of structural change. In other words, Markov-switching model conjectures that two or more regimes could have prevailed over the course of history. That is, there is a regime, or a state, when inflationary expectations are low and one or more regimes when they are high. Series of shifts between the regimes (timing of breaks) occur in probabilistic fashion, thus endogenously rather than being imposed by a researcher. Such a model may be able to pick up endogenous shifts in the level of inflationary expectations in Russian economy and give superior results. In addition, Markov-switching model may be complemented by inclusion of other potential variables that explain inflation and are available for forecasts, i.e., unemployment, money supply, and output gap. Furthermore, it is more likely that such model may prove rational not only in the weak sense but also by the strong efficiency criteria described in the thesis.

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# Appendix

In order to test the null hypothesis, $H_0$: $B(L) = 0$, the first step of the Hsio's procedure is to specify the own lag length of $\pi$. This is best achieved utilizing (A.1) derived from (2):

$$\pi_t = c_0 + A(L)\ \pi_t + e_t \tag{A.1}$$

Determination of the own lag length for $\pi$ could be achieved by varying a lag in the autoregression (A.1) from 1 to $x$, where $x$ is the highest order lag, $c_0$ is a constant, $A(L)$ is a distributed lag polynomial such that $A(L) = \sum_{a=1}^{x} A_a L^a$, $L$ is the lag operator so that $L^a \pi_t = \pi_{t-a}$, and $e_t$ is a zero mean white noise error term. Thus, the first step of the Hsiao's procedure is to regress $\pi_t$ on $\pi_{t-a}$ to obtain the sum of squared residuals (SSR) from the sample $T$, where $a = 1, 2, \ldots, x$. The obtained SSR is used to compute the $FPE$, as defined by Akaike (1970), for each autoregression described in (A.2):

$$FPE_{(a)} = (T + a + 1) / (T - a - 1) * \mathrm{SSR}_{(a)} / T. \tag{A.2}$$

Thus if $x$ in (A.1) were set at 15, as in our test, there would be 15 $FPE$s obtained from (A.2).[119] The order of a lag of a one-dimensional autoregressive process, which yield the smallest $FPE$ is chosen and denoted as $FPE_{(a^*)}$.

Having found the order ($a$) of $A(L)$, in the second step of Hsio's procedure, determination of whether monetary variables enter the $\pi$ equation is made. This amounts to testing the null hypothesis $H_0$: $B(L) = 0$. Thus the second step begins with the estimation of the bivariate (A.3)

$$\pi_t = c_0 + A(L)\pi_t + B(L)m_{i,t} + e_t \tag{A.3}$$

[119] If the appropriate lag length turns out to be 15 for any variable, prudence required that the maximum lag length was allowed to extend beyond 15 by at least 3 lags to check on whether a longer lags were more appropriate. This practice wais further extended should the longest lag under consideration again be chosen as the optimal one.

where $m_{i,t}$ are monetary variables $m2$ and $m2x$ considered one at the time, and $B(L)$ is a distributed lag polynomial defined in a similar manner to $A(L)$. In (A.3) $\pi_t$ is thus used as the controlled variable, with the order of lag(s) set at $a^*$, and $m_{i,t}$ is treated as the manipulated variable. From (A.3) we again obtain SSR needed to compute the *FPE*s of the controlled variable according to the formula given by (A.4). As in the step one, we vary order of lags of $m_{i,t}$ over $b = 1,2,\ldots, x$ and determine the order, which yields the smallest *FPE*, say $b^*$. The corresponding two-dimensional $FPE_{(a^*,\, b)}$ is

$$FPE_{(a^*,\, b)} = (T + a^* + b + 1) \,/\, (T - a^* - b - 1) * \mathrm{SSR}_{(a^*,\, b)} \,/\, T. \qquad \text{(A.4)}$$

In step three of Hsio's procedure, the smallest *FPE*s of the steps one and two are compared and concluded that money Granger-causes inflation ($m_i \Rightarrow \pi$) if $FPE_{(a^*,\, b^*)} < FPE_{(a^*)}$, and money does not Granger-causes inflation ($m_i \not\Rightarrow \pi$) if converse is true. In other words, if the *FPE* obtained from the step two is smaller than the *FPE* obtained from the step one then the optimal model for predicting inflation ($\pi$) would be the one including $a^*$ lagged $\pi$ and $b^*$ lagged $m_i$. If, however, the converse is true, one-dimensional autoregressive representation for $\pi$ should be used. By the same token, according to Hsiao (1981), the null hypothesis, $H_0$: $B(L) = 0$, is rejected if $FPE_{(a^*,\, b^*)} < FPE_{(a^*)}$ and not rejected if converse is true.

In step four of the Hsiao's procedure, the steps one to three are repeated for the $m_i$ processes. Firstly, the *FPE*s resulting from the treatment of each variable of broad money supply as one-dimensional autoregressive process are found. Secondly, having specified the order of autoregressive operator on $m_i$, $m_i$ and $\pi$ are then treated as a controlled and a manipulated variable, respectively. As above, this is in order to compute the optimum lag of the latter and the *FPE*s of the former. The purpose of this exercise is to test now whether inflation Granger-cause money supply. Eqs. (A.1) to (A.4) are then transformed to reflect changes of the treatments of variables $\pi$ and $m_i$, resulting into the corresponding eqs. (A.5) to (A.8), presented below. Needless to say, this is a tantamount to testing the null hypothesis, $H_0$: $C(L) = 0$.

$$m_{i,t} = c_0 + D(L)\, m_{i,t} + e_t \qquad \text{(A.5)}$$

$$FPE_{(d)} = (T + d + 1) / (T - d - 1) * \mathrm{SSR}_{(d)} / T \tag{A.6}$$

where $d$ is the order of lag(s) of the one-dimensional autoregressive money supply process varying from 1 to $x$, and $d$ which yield the smallest $FPE$ is chosen and denoted as $FPE_{(d^*)}$.

$$m_{i,t} = c_0 + D(L)\, m_{i,t} + C(L)\pi_t + e_t \tag{A.7}$$

$$FPE_{(d^*, c)} = (T + d^* + c + 1) / (T - d^* - c - 1) * \mathrm{SSR}_{(d^*, c)} / T \tag{A.8}$$

Once again, $d^*$ is the optimum number of lags for $m_{i,t}$, computed from (A.6), and $c$ is the order of lag(s) varying from 1 to $x$, where the $c$, which yields the smallest $FPE$, is denoted as $c^*$, as practiced above.

The order of the one-dimensional autoregressive process of $m_t$, obtained by using the $FPE_{(d^*)}$ criterion in (A.6) is compared with the corresponding two-dimensional $FPE_{(d^*, c)}$ obtained from (A.8). If the former is less than the latter, one-dimensional autoregressive representation for $m_i$ is used. This is equivalent to the acceptance of the null hypothesis, $H_0$: $C(L) = 0$. If the converse is true, we say inflation Granger-causes money supply ($\pi \Rightarrow m$), and the optimal model for predicting $m_i$ is the one including $d^*$ lagged values of $m_i$ and $c^*$ lagged $\pi$. Naturally, this amounts to the rejection of the null hypothesis, $H_0$: $C(L) = 0$.

The combinations of the $FPE$s obtained from (A.2), (A.4), (A.6), and (A.8) in the Granger-Hsiao's (1981) procedure, leads to the distinction of the four theoretical cases of Granger-causality between money and inflation, as mentioned above:

(i) unidirectional causality from $m$ to $\pi$ ($m \Rightarrow \pi$) : $FPE_{(a^*, b^*)} < FPE_{(a^*)}$ and $FPE_{(d^*, c^*)} > FPE_{(d^*)}$, or $B(L) \neq 0$ and $C(L) = 0$;

(ii) unidirectional causality from $\pi$ to $m$ ($\pi \Rightarrow m$): $FPE_{(d^*, c^*)} < FPE_{(d^*)}$ and $FPE_{(a^*, b^*)} > FPE_{(a^*)}$, or $C(L) \neq 0$ and $B(L) = 0$;

(iii) feedback or bilateral causality, from $m$ to $\pi$ and $\pi$ to $m$ at the same time ($m \Leftrightarrow \pi$): $FPE_{(a^*, b^*)} < FPE_{(a^*)}$ and $FPE_{(d^*, c^*)} < FPE_{(d^*)}$, or $B(L) \neq 0$ and $C(L) \neq 0$; and

(iv) independence - no causality from $m$ to $\pi$ nor vice versa ($m <\neq> \pi$): $FPE_{(a^*, b^*)} > FPE_{(a^*)}$ and $FPE_{(d^*, c^*)} > FPE_{(d^*)}$, or $B(L) = 0$ and $C(L) = 0$.

From a practical point of view, or from the standpoint of a policy maker, only variables satisfying conditions in (i) and (ii) above, may be utilized as intermediate targets, via the instrument variables, for controlling the goal variable.[120] In other words, for a measure to be useful as an intermediate target, in addition to being correlated with a goal variable as well as reasonably controllable by policymakers, it should also have the feature of being "exogenous" or causally prior to the goal variable and have no significant feedback from the goal variable. Thus, for a variable to be useful as a policy target, unidirectional causation from it to the goal variable is a necessary condition, though not necessarily sufficient. That is not the case in (iii) and (iv) above because variables in these two cases are not exogenous.

Finally, in step five of Hsio's procedure, we combine all single equations specifications in order to identify the system. We pay a particular attention at the direction of causality as outlined in the four cases above. Thus, if for example, the goal variable is chosen to be $\pi$, then the usefulness of $m_i$ as a policy target rests on the direction of causality with the goal variable $\pi$.

Analogous formula for the *BEC* criteria, in the univariate distributed lag case, described by (A.1), can be expressed as follows:[121]

$$BEC_{(a)} = \mathrm{SSR}_{(a)} / T + (a\mathrm{SSR}_{(x)} / T \ln T) / (T - x - 1) \tag{A.9}$$

where the variables are as described above, and the minimum *BEC* correspond to the optimal lag lengths ($a^*$). The formula could be modified in a straightforward manner to account for the bivariate distributed lag case for both aggregates of money supply.

[120] Depending on the choice of the goal variable, only one of these two cases could be utilised; i.e., if the inflation rate ($\pi$) were a goal variable, then only $m_i$ in case (i) (unidirectional causality from $m_i$ to $\pi$) could be utilised as a policy target.

[121] For further details see Jones (1989) or Geweke and Meese (1981).